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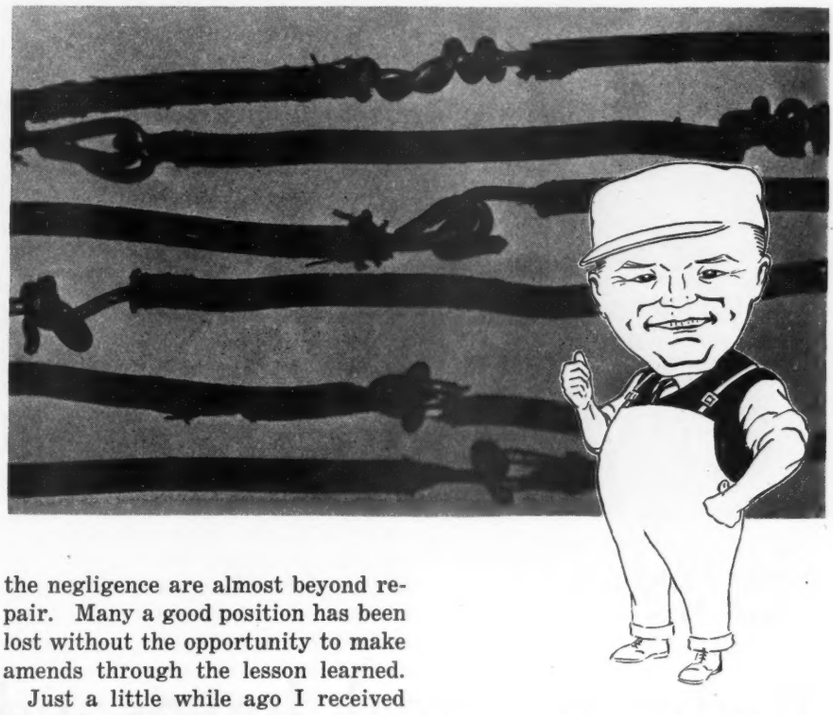
Pride in Workmanship

Will Cure More Troubles Than Expert Knowledge Will When It Is Carelessly or Indifferently Applied to a Job



MOST folks take pride in doing a good job and setting standards of workmanship that command both respect and admiration. This trait of human nature associated with an active mind and healthy body can be found in presidents of big corporations and downward through their organizations to the janitor who has places for everything and uses them, keeps his own yard clean and worries not about that of his neighbor. Evidences of this kind of pride in work done and responsibility carried show up in many ways. Likewise evidences of a lack of it come to light in equally as many unexpected ways, and always reflect unfavorably on the man whose negligence, carelessness, or indifference allows damaging evidences of poor management or poor workmanship to pile up around him.

Excuses for poor work, sloppy in character or a makeshift even in temporary repairs, never quite compensate for good intentions, and when such work is discovered by others called in to make corrections, the damages to the party guilty of the negligence are almost beyond repair. Many a good position has been lost without the opportunity to make amends through the lesson learned.

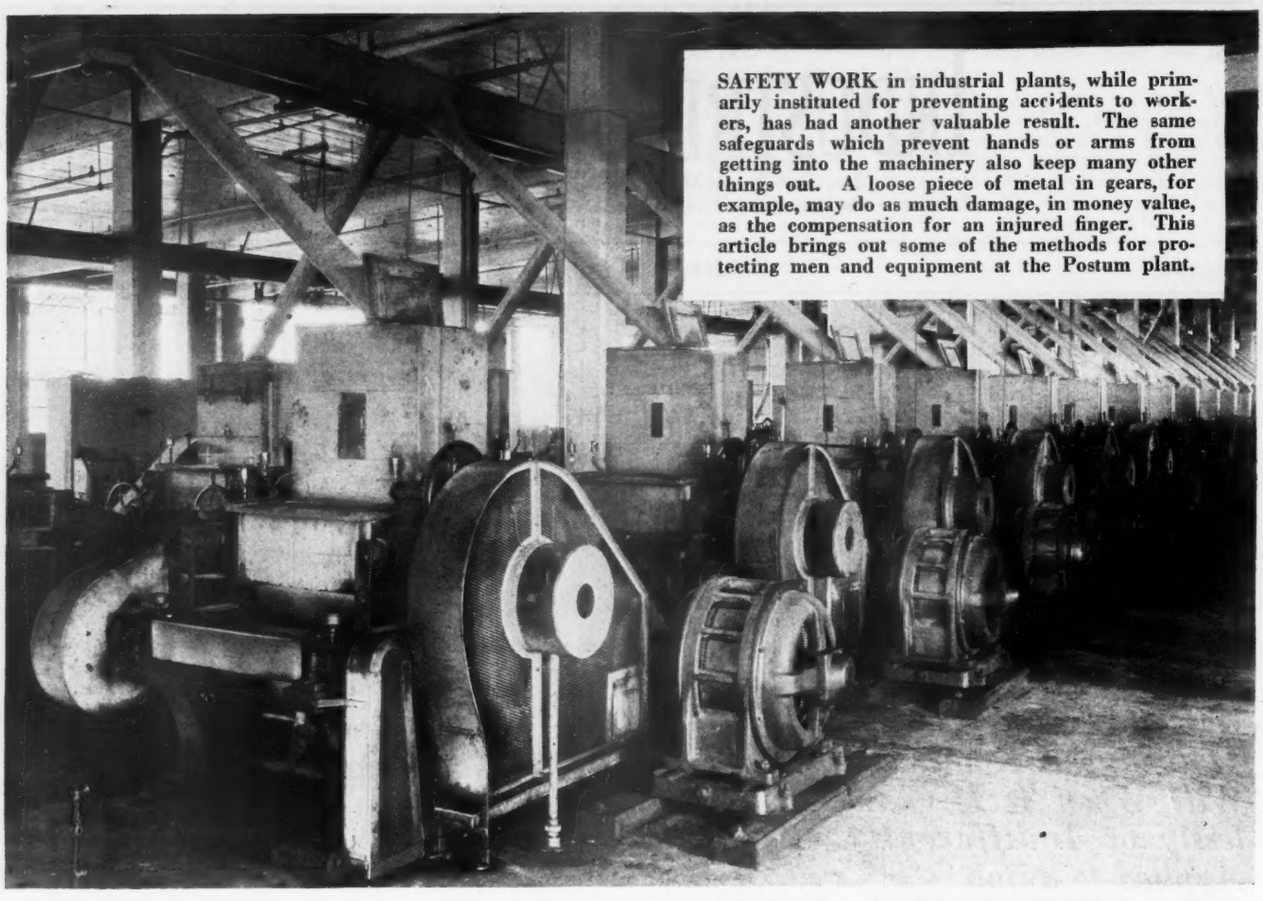
Just a little while ago I received the following letter and the accompanying photograph which illustrates all of the points I am trying to bring out. That letter reads as follows:

I am sending you herewith exhibits from A to Z on, "How it should not be done." These specimens were cut out of a two-wire line within a distance of 9 ft. 6 in. in a building used for five or six suites of living quarters over a block of stores. The wires are weatherproof and were used to carry the entire lighting of the upper floor.

We were asked to investigate the cause of a very high bill by the landlord's agent and our attention was drawn to a very noticeable hum in a certain location, which seemed to indicate the use of a heater, contrary to the rules of the building. After failing to locate the heater, we cut off the wires and pulled them out. What we found is shown in the photograph and was the cause of the hum. This is the first time in my experience that I have found a hum from such a source, and I could not believe that a human being with normal intelligence would do such a job.

It is hardly believable that any wireman would willfully install wiring in this manner. The party who did the job is not present to justify his case, but it is difficult to imagine what he could say in defense of his standards or workmanship. This picture is mute evidence of gross negligence for which there can be no satisfactory excuses. But the man who supervised this workman is partly to blame. Punishment will not cure such trouble, but pride in workmanship would. It's your job as the boss to develop this in your men and a kind word about a good job as well as criticism of poor workmanship will go a long way.

Practical Pete



SAFETY WORK in industrial plants, while primarily instituted for preventing accidents to workers, has had another valuable result. The same safeguards which prevent hands or arms from getting into the machinery also keep many other things out. A loose piece of metal in gears, for example, may do as much damage, in money value, as the compensation for an injured finger. This article brings out some of the methods for protecting men and equipment at the Postum plant.

Method of guarding flaking mill in the new Post Toastie building.

In this department the cooked and tempered grain, called grits, passes through heavy rolls which roll it out into flakes. The grain is served through chutes from above and passes on down to the floor below where it is toasted and then boxed. Each mill is individually driven by a 35-hp. motor, through a silent chain. All the equipment is raised from the floor so that it can be more easily cleaned underneath. The top of the guards are of solid metal, while in some cases the sides are open. Any of these guards may be easily removed by loosening a few bolts and they are made substantial enough so that they will fit back into place easily. Small doors are provided where it is necessary to get inside the guards for lubrication. The panel board controlling these motors is shown in an accompanying illustration.

Some Practices That Are

Reducing Breakdowns and Lost-Time Accidents

In a Large Food Products Plant Through Protection to Operators and Machines That Includes Inspection and Safety Precautions

By R. R. THOMSON

General Superintendent The Postum Cereal Co., Battle Creek, Mich.

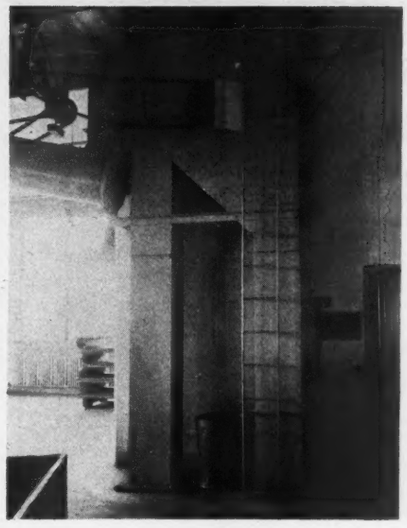
SAFEGUARDING in the industrial plant has two purposes: (1) To protect the operator or others who may come near and (2) To protect the machinery, as an accident to an operator or others, such as may result from premature starting, may often also be disastrous to the machine. The same safeguard, thus, often serves a double purpose. Because, as has often been stated, "The best safeguard is a careful man," much work must be done toward educating the men to be careful by repeating the safety lesson so frequently that none can forget it.

The new Post Toastie plant is not only provided with carefully planned safeguards but has the advantage of a plant safety organization that functions. While all of the machinery in other buildings in the works is well guarded, the new building has the guards designed and installed as a unit instead of piecemeal or as an afterthought, as is so often the case. Practically all the machines were built in our own shop and the guards constructed as a part of them. This not only makes better-designed guards but also better-appearing guards. Appearance is especially desirable here as many visitors come to the plant annually to see the process of making Post Toasties. All the machines and guards are painted with a heavy coating of gray enamel to match the machines, which are also enameled.

These safeguards are generally made out of Steelcrete expanded metal, 22 gage, with diamond-shaped slits about ½ in. x 1 in. This comes in sheets 36 in. x 120 in. and is cut to shape and fastened with stove bolts to a framework of 1-in. x 1-in. x ⅛-in. angle-iron, on heavy sheet metal cut and formed to shape.

In some places, as around moving belts, light sheet iron is used for part of the guards to retain any particles of dust which might be thrown out or stirred up by the rapid motion of the belt or chain. Also this solid top on the guard makes it easier to dust and clean and less liable to catch dirt than if it were perforated on top. Cleanliness is an important factor in a food-products plant.

These machine guards are made in the sheet metal shop which has facilities for cutting the expanded and sheet metal, for shaping it and also for bending the angle-iron frames. Expanded metal and angle iron of various weights and gages are kept in stock so that additional guards may be obtained as required on new equipment or when it is necessary to move or rebuild any machine. In addition, each guard is made so that it can be removed and is substantial enough so that when taken off it will hold its shape and can be easily replaced without forcing. This is a point too often neglected in the making of guards but it takes very little more time to make a good guard than a poor one. The legs of the guard which rest on the floor fit into sockets fastened to the floor. This facilitates the removal of any guard as it is only necessary to loosen a few screws. Small doors or openings are provided in all guards where it is necessary to oil or adjust parts on the inside. This makes it unnecessary to remove the entire guard except when making extensive repairs or adjustments of the machinery. Sufficient space is left within the guard to prevent it from rubbing on the belt, gearing or any other moving parts. All safeguards on machinery are built according to the standards approved by the liability insurance companies so that we get a high rating by the inspector which in turn affects the insurance cost because approved guards decrease the risk and the insurance premium.



One of the permanent ladders for overhead lubrication.

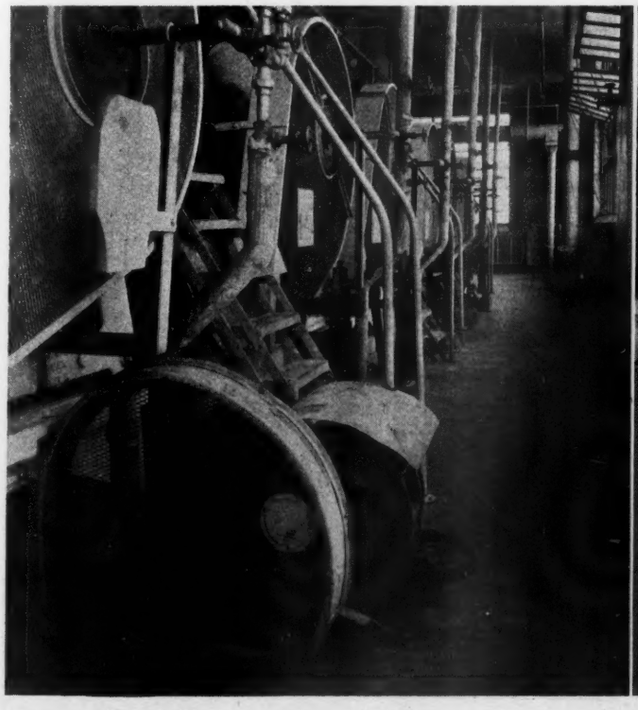
In practically all places where continual lubrication is required overhead ladders such as this are built in permanently. In addition to making it easier to oil this elevator drive a special guard prevents the oiler from coming accidentally in contact with the drive.

Practically all the machinery in this plant is driven by individual motors, connected by belt or silent chain to the machines. Individual drives are used because they make a better looking room and also stir up less dust than the belt drives. Both of these are important considerations in a food factory. Other reasons for individual drives are greater ease in controlling individual machines and also the better distribution of power.

Special attention is given to safeguards for oilers and others whose duty carries them regularly into dangerous locations, as well as for millwright inspectors and other repairmen who must on occasion also be exposed to an out-of-the-way hazard. Permanent platforms are used

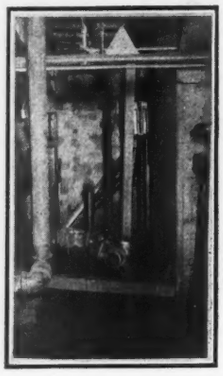
Two other steps in the process of making Post Toasties.

The illustration at the left shows a row of the rotary cookers in which the corn grits are cooked. Notice here particularly the opening in the guard for oiling and also the special "helmet" over the motor to protect it from dripping hot water. A simple strap iron guard protects the wiring connections of the motor. Here, a permanent ladder is set in between each group of machines for the use of the operator or for inspection. The illustration at the right shows another view of the rotary cooker and the drive for the collecting belt underneath, upon which the cooked corn is dumped. In this case, in addition to leaving a door in the guard, grease cup and oil pipe connections are extended up through the guard so that it is unnecessary for the oiler to endanger himself or go to the trouble of opening the guard. Here, two sets of hangers are inverted to form a floor stand and support a short shaft.



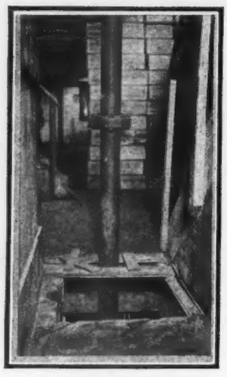
Four Bulletins Which Teach Safety Lessons

How the Camera and Text Can Be Used to Play Up Unsafe Practices



Watch Your Step.

When a piece of machinery is braced by a stick of timber, as shown in the photograph, even the most careful workman is likely to get a fall. You will notice this beam is just the right height from the floor to catch the lower parts of the shins, and located as it is right in a rather poorly lighted passageway, the wonder is that more injuries were not caused and that those who did stumble were not more seriously hurt.



THINK
of the Other Fellow's Safety.

This apparently was not practiced by the workmen who made the opening, here shown, in the floor of one of our departments, and it nearly resulted in injury to another man.

A foreman in a department where this picture was taken went around at closing time and turned out all lights, the last one near this passageway. Then with his eyes dimmed by the change from bright light to darkness, he started through the passage, not knowing of the hole in the floor, left unprotected by those who opened it during the day. For some reason he took the precaution to feel along the floor with his feet and thus just chanced to avoid a fall.

What a bad injury he would have received if he had gone through the hole into the steam line tunnel, bumping his head on the flange bolts as he passed.

Think Safety for yourself and for the other fellow also.

Bad Business

Tools and material carelessly left on stairways may cause someone serious injury, suffering, and loss of time and money

We must be mindful of the safety of others as well as ourselves. Thoughtfulness will prevent a large proportion of our injuries.

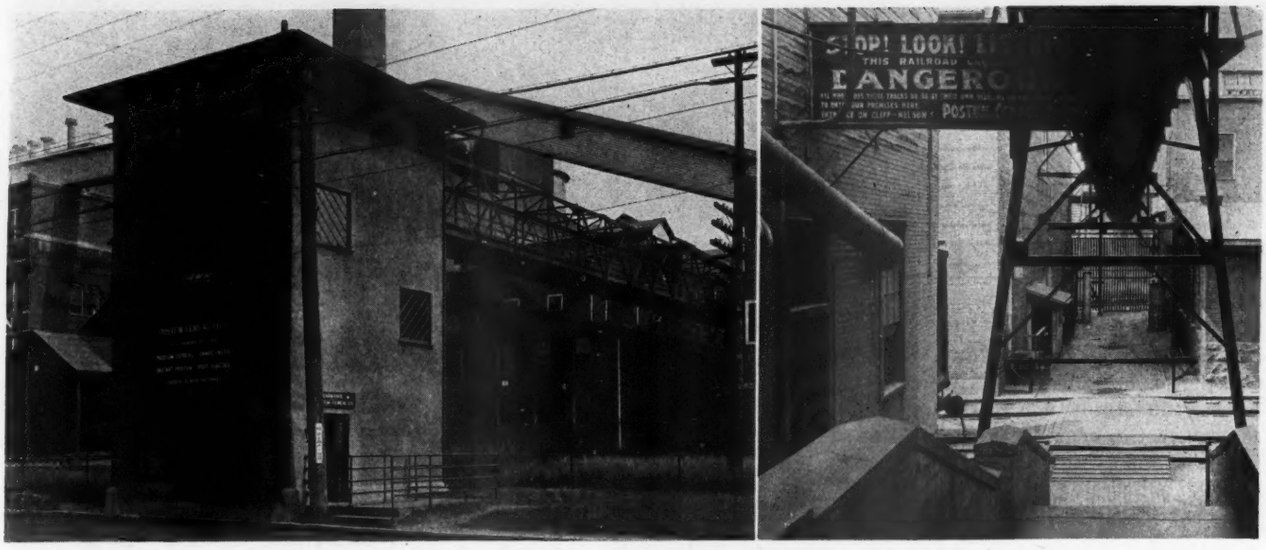
Let's be Careful!

It Happened Just This Way

When someone leaned the six-foot piece of pipe against the sliding gate, he didn't think what the result might be. The gate was pushed back just as a man was passing, and he barely escaped being struck by the falling pipe.

There have been several injuries in the Postum plant on account of brushes, shovels, crow-bars, boards, and other objects which were so placed that sliding doors, etc., made them fall.

Think accident prevention and satisfy yourself that you are not causing the man who follows you to get hurt.



The entrance to the plant of the Postum Cereal Company and an interior view of the yard.

The building in the foreground is an entrance to the bridge which takes the employees and visitors over the railroad track when entering the plant. The view at the right is taken underneath this bridge facing toward the entrance. Before a worker can step out upon the switch track, he must first lift the gate which is so balanced that it will swing back into position automatically.

whenever possible, as may be seen from some of the illustrations. These make it almost unnecessary to use ladders for oiling or to build platforms or scaffolds for inspection or repair of overhead motors. Whenever possible, motors are placed on or near the floor so that only a few ladders or platforms are necessary.

In many plants it is the policy to do no more toward providing safeguards for oilers or maintenance workers than may be required by the state code or by the insurance inspectors. The management of some companies relies upon the type of men engaged in this work, realizing that they are operating under somewhat more hazardous conditions than ordinary and so taking greater precautions. The experience and statistics of the accident insurance companies have shown that this is not the case and that even the most isolated hazards may cause a serious accident the first time it becomes necessary for a man to go close to the hazard. Unusual precautions to prevent accidents are taken in our plants.

In one case, for example, as shown by one of the illustrations, the grease cup is extended through the mesh of the guard to the outside so that there is seldom any necessity of going inside the guard. In other cases, similar provision is made for oiling from the outside and so there is less opportunity for the oilers to be injured.

Another function of the safeguards, and one which is too often overlooked, is their value in protecting machinery. A guard around the silent chain, for example, is of almost as much value in preventing foreign objects, such as wrenches, bolts or nuts, from getting between the chain and sprockets as in keeping hands and arms out.

All electrical equipment is likewise thoroughly protected. In the flaking room where each flaking roll is driven by a 35-hp. motor, the motors are controlled in groups of four with a separate panel box for each group, as shown. Here, because only one motor of a group is started at a time, a single G. E. CR 1034 Type NR compensator is connected into the lines for each two groups of motors and their panel boards. The actual starting is handled by a G. E. barrel switch with the compensator coils removed and overload relays mounted in their place. This arrangement made possible a considerable saving in the installation cost. Each piece of starting equipment is identified conspicuously as is also the switch in the panel box, as may be seen from the illustration of an installation.

Guards and cross-overs on a conveyor belt.

When this belt was installed without guards, some of the workers would step on the belt when crossing over. This easily-constructed pipe guard fixes definite cross-over openings. In addition steps are built on a level with the belt and make stepping on the belt unnecessary. A section of a worn-out conveyor belt is tacked onto the steps to eliminate any slipping hazard.

Motors of 5 hp. or under are started with G. E. CR 1038 safety switches, except that thermaloads are added when used in case of remote control.

All panel boards are made in the electrical department to fit the particular operating requirements. When mounted the board shows the location of each motor connected in to it and the size of fuse to be used. This is checked frequently to see that the wrong size of fuse does not get into the panel board. These boards are kept locked and only an authorized person has access to them.

Power is purchased at 5,000 volts, 60 cycles, three-phase and stepped down to 440 volts for power and 110 volts for lighting service. Altogether about 625 motors ranging from ½ hp. to 250 hp. are installed in the plant. All motors are placed and removed by the mechanical department, but all connections or disconnections as well as inspections, oiling and servicing are handled by the electrical department.

All motors are inspected once, and some twice, a day. On his trip, the oiler feels the bearings, inspects belts, looks over all the grounded

These packing machines are approximately 100 ft. long and all moving parts are carefully guarded.

Here, as in other parts of the plant, all the machinery is set up from the floor so that it can be more easily cleaned underneath. Also, guards with sheet metal tops and expanded metal sides are used. These machines fill the cartons with Post Toasties, close the box and seal it. As the boxes are discharged, they are packed into a large container which is carried on to the shipping room on the belt conveyor shown in another illustration.

static connections, and listens for rubbing rotors. If he hears any sound, he immediately shuts down the motor and inserts a feeler between the stator and rotor and if necessary the bearing is changed at the first opportunity. Also the oiler carries a flash light and looks into the bearings to see that the oil ring is turning. We have found that the ordinary oiler has a tendency to use too much oil rather than too little. We have also found that it pays to employ a higher grade man for oiling than is ordinarily found in an industrial plant.

Once a year the whole plant is shut down and feelers inserted in all motors. Any that show evidence of wear have their bearings changed, as we do not want to risk a shutdown in the middle of the year while the plant is busy and operating 24 hr. per day. During this annual shutdown, the insulation on half of the motors is varnished each year. In that way, all the motors are gone over every two years.

This careful inspection and annual overhauling has resulted in reducing motor failures to such an extent that only fourteen motors required rewinding in a period of about three years.

These rewinds were due to:

Leaky pipes	3
Leaky roofs	4
Use of acid extinguisher	1
Fire	2
Running single phase	2
Shorted coils	1
Metal in coils	1
Total	14

This last failure was due to a piece of metal getting in between a rotor and stator. As a result of this analysis, motors driving cookers and other equipment where steam and water pipes are placed overhead are now provided with a helmet or shield, as shown in one of the accompanying illustrations. This will turn the water enough to protect the motor from any leaky connections.

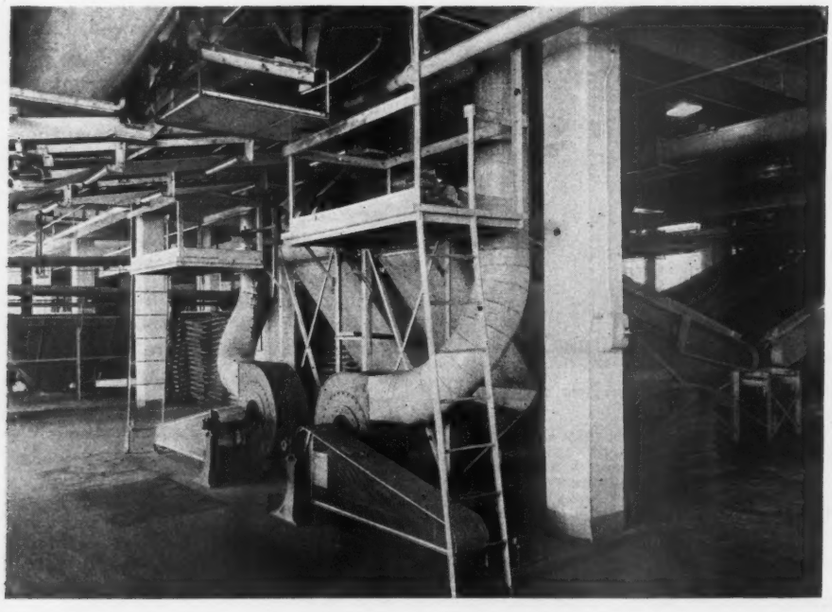
It will be noticed that none of these failures was due to bearing trouble. However, due to the careful inspection and our policy of removing a bearing before it has an opportunity to do damage, a possible forty-nine failures were prevented by removing that many worn bearings. An analysis of the cause of worn bearings shows that forty-one were due to natural wear, two to tight belts and six to unknown causes. Due to the care taken of the motors and the inspections we have found it possible to get along with a comparatively small number of substitute motors. In no case have we more than one extra motor of any size or type.

While these precautions are not ordinarily looked upon as safety practices, nevertheless, the security of continuous operation depends upon them. Without this care, it would be difficult to operate continuously. Interruptions in some parts of the process would result in a total loss of the product.

Educational Advantages of the Plant Safety Department

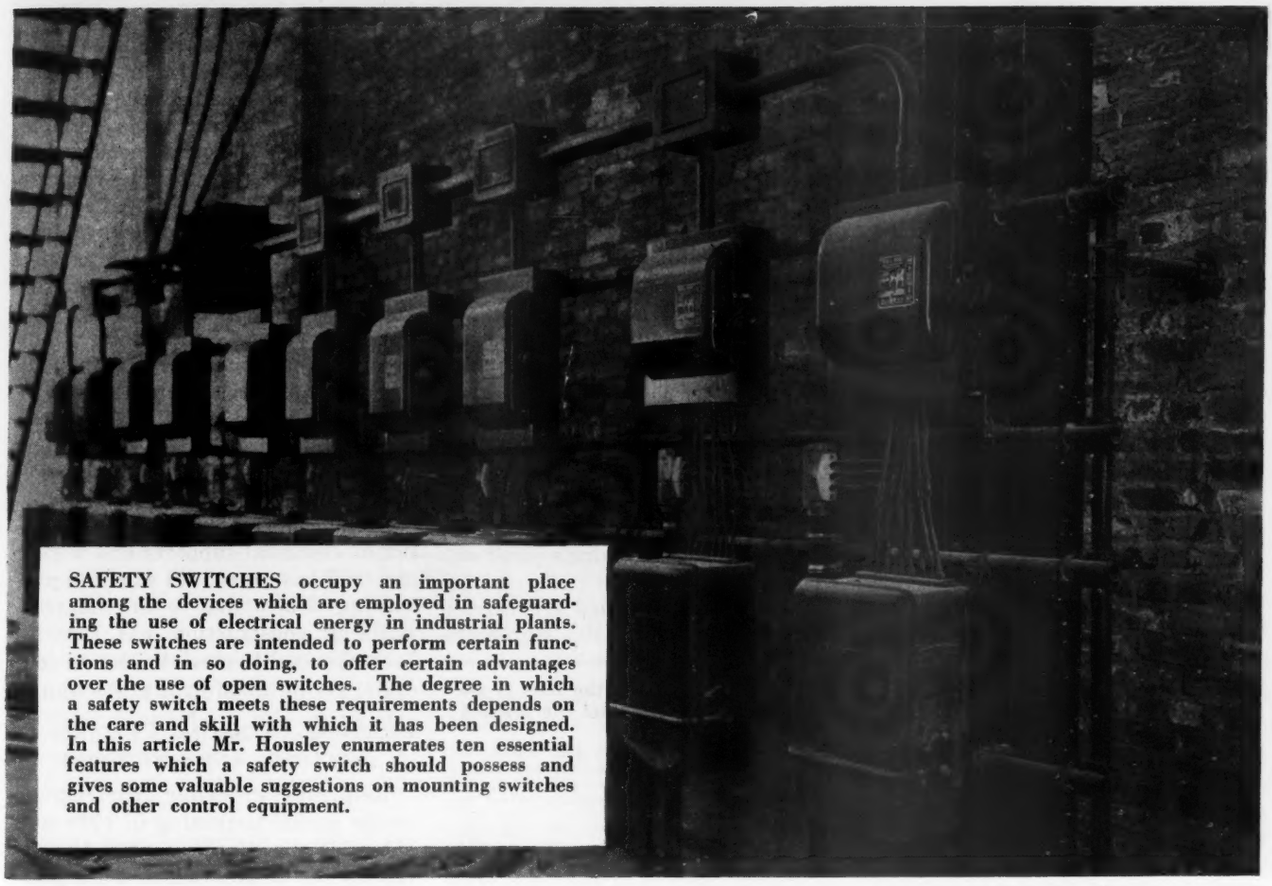
Even though all new work is carefully guarded as best we know how, experience and time show up new hazards which had not been thought of. One good example of this was a hot return pipe line near a stairway. This was left unguarded as it was not where one would ordinarily touch it, although it was within reach from the stairway. However, one day a man lost his balance on this stairway, grasped the pipe and burned his hand. The pipe,

(*Please turn to page 160*)



Ladders and maintenance platform at the cooling screens and storage hoppers.

The belt conveyors which receive the toasted corn flakes from the ovens on the floor above discharge them upon these cooling screens and storage hoppers. The storage hoppers fill the important function of securing "balance," the big problem in connection with any progressive manufacturing. Magnets over the conveyor belt remove any chance metallic particles. In addition, many other magnets are installed, particularly ahead of the flaking process, so that there is no opportunity for metal to get into the rolls. Also, here are two of the many examples in the plant of permanent platforms and fixed ladders for protection of millwrights and oilers. These are used here not only because of the saving effected in the time of skilled men but also from a safety standpoint. The flakes go from here to the packing machine on the floor below, shown in another illustration.



SAFETY SWITCHES occupy an important place among the devices which are employed in safeguarding the use of electrical energy in industrial plants. These switches are intended to perform certain functions and in so doing, to offer certain advantages over the use of open switches. The degree in which a safety switch meets these requirements depends on the care and skill with which it has been designed. In this article Mr. Housley enumerates ten essential features which a safety switch should possess and gives some valuable suggestions on mounting switches and other control equipment.

Pump room compensator rack consisting of eight 50-hp. and two 15-hp. safety-switch and compensator units. Eight of the switches are 100 amp. rating and two are 30 amp., 500 volt rating. All switches are quick-make-and-break type. A temporary feed line is shown entering the main junction box. The permanent conduit lines enter the box at the back. The junction boxes above the switches, are for pulling and splicing wires and are arranged to permit removal of any switch as a unit. One end of the conduit leading to the motor is bolted to the rack alongside the compensator.

Practical Viewpoints on the

Essential Requirements of Safety Switches

With the Reasons Therefore and Suggestions on Mounting Them for Safety and Ease in Making Replacements

By J. ELMER HOUSLEY

Electrical Engineer, Aluminum Company of America, Alcoa, Tenn.

WITH the rapid and widespread increase in the use of electrical energy in industrial plants, there have also been many advances in safeguarding the use of this energy in the industries coming under the writer's observation during the past fifteen years. Until about 1912 the motor switch and the other knife switches were usually exposed and all wiring was run open. Between 1912 and 1915 some conduit was used and it would ordinarily be found encasing the vertical leads running from the building feeder, mounted on the roof trusses or elsewhere overhead, down to the motor switch. During this period the open knife switch was encased within a wooden box which was made of generous size and lined with sheet asbestos paper. One of these wooden boxes is shown in Fig. 1. A measure of protection was thus provided for the wiring most susceptible to damage and the box was protected against the dangerous exposed switch. Injuries resulting from objects carried by workmen striking the live parts of the switch and giving the men a shock as well as shorting the switch, and accidental closure of the switch, had demonstrated the need of some protection. As the most commonly used building material was wood, the switchbox was made of wood. It represented a distinct advance in the art at that time and helped to reduce accidents and loss.

Wooden Switchboxes Were Fire and Accident Hazards

Consider, however, for a moment just what happened during the period the wooden switchbox was in use. It provided a convenient place for the storage of lunches, waste, oil cans, and similar material possibly because the more timorous persons would not investigate the switch boxes. In time the oil cans would be pushed too far into the box and a short circuit across all leads would result; the workman was invariably seriously burned. Hot contacts would

set the waste and lunch papers on fire, and the box and the adjacent wiring would often be damaged before the blaze was extinguished. Sometimes a very serious fire resulted. Occasionally in reaching into the box to operate the switch the workmen would grip the live switch blade instead of the handle, with unpleasant if not always serious results. Also, when operating the knife switches, if the men did not always take care to see that the compensator was tripped off when the switch was opened or closed a flashover between phases usually occurred, if the motor was large, due to the heavy arc across the contacts of the switch creating a metallic-vapor path for the current. With a large generating station furnishing the power a serious condition was created. This was not due to the use of wood boxes because the situation was worse when all switches were exposed, but the summary of conditions given above indicated the need for further safeguards.

Early in 1916 several externally-operated, enclosed switches with steel boxes were installed and these switches eliminated about 75 per cent of the accidents mentioned above. The improved box in use today will go far toward reducing the remaining 25 per cent of accidents, where education and proper instruction of the operating men is given. All wood switchboxes then in service were replaced with the new switch and a great reduction in operating delays was noticed. Conduit wiring was used throughout with the steel switchboxes, with all metal parts of the system thoroughly grounded. The rapid deterioration of the open wiring and wooden boxes, together with the low scrap value when the equipment had to be moved and reinstalled, was eliminated by the use of a more metallic construction.

Pipe Framework Replaced Wooden Panel and Switch Supports

This wiring had, up to 1918, been mounted on the same type of wood board which supported the previous layout of wood switchbox and compensator. We did not eliminate flashovers and short-circuits within the steel switch box, but the number and serious extent of burns suffered by the workmen were minimized. Occasionally the wood supporting board or panel would catch on fire from these short-circuits. A further improvement, therefore, suggested itself and beginning early in 1918 all compensators as well as starting switch panels were constructed of 1¼-in. wrought-iron pipe. A very simple rack was developed using three standard switchboard pipe fittings; the floor flange, pipe cross and single panel support. General views of this construction are shown in the headpiece at the beginning of this article and in Fig. 4. For a single or double switch and compensator rack, two vertical standards, four cross pieces and two horizontal wall braces are regularly used. The bill of material for a single rack is as follows:

2 pieces 1¼-in. pipe, 7 ft. long.
4 pieces 1¼-in. pipe, 3 ft., 6 in. long.
2 pieces 1¼-in. pipe, 1 ft., 6 in. long.
4 No. 5171 "Three E" floor flanges.
10 No. 5186 "Three E" pipe crosses.
8 No. 1618 "Three E" single panel supports.

The pipe and fittings are carried as regular stock in the storeroom.

Fig. 1—The old and the new types of safety switches, and the method of mounting them.

The illustration at the left shows a wooden box enclosing an ordinary knife switch. The switchbox and compensator are mounted on boards nailed to 4-in. by 4-in. wooden posts. Note the overhanging roof above the switchbox, to protect it from drip. At the right is shown a modern safety switch with compensator mounted below it. This switch is rated at 30 amp., 500 volts and controls a 15-hp. motor driving a rotating drying kiln. The conduits are arranged so that either switch or compensator may be removed and replaced in a few minutes, in order to cut production delays to a minimum in case of breakdown. The construction of the supporting pipe framework is clearly shown in this and some of the other illustrations.

Each rack has some slight variations in it and the exact dimensions are determined in the field to fit the location. Practically all of the vertical uprights are 7 ft. long. It is a simple matter to slide the cross members up or down to fit any size of switch or compensator. The height of switch and compensator is made convenient for the operator to reach. In groups, sufficient room is allowed between compensators to permit the installation of a large compensator if it should become necessary. We have standardized on a certain make of compensator and use these with all makes of motors. We cannot use overload relays because of corrosion from chemicals.

In the past five years the fireproofing of electrical supports and wiring material has proved its worth in preventing delays due to fire hazards. Building construction has likewise been changed to steel, brick and concrete, giving maximum protection.

Desirable Operating Features of Enclosed Knife Switches

Returning to switch construction, at the period beginning in 1918 considerable attention was given to remedying the defects which were present in the prevailing types of switches. It was desired to make it necessary to close the switchbox door before closing the switch, and likewise to open the switch before opening the switchbox door. A type of

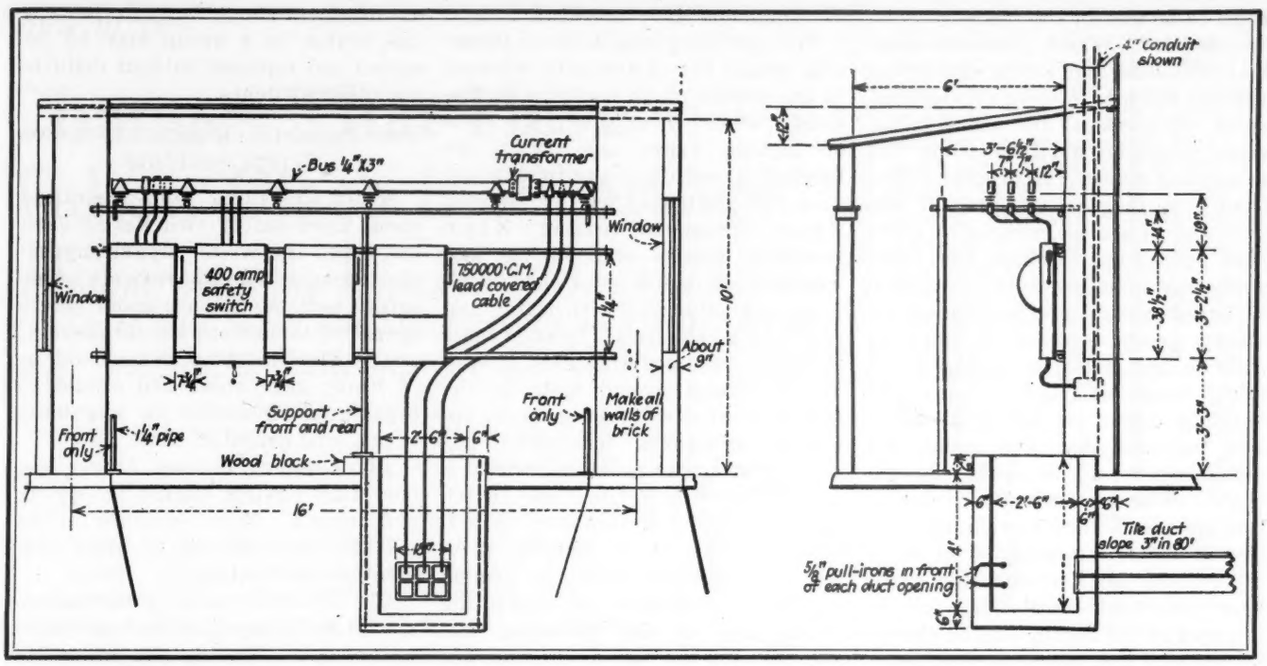


Fig. 2—Details of distribution panel designed for ease in metering and making extensions.

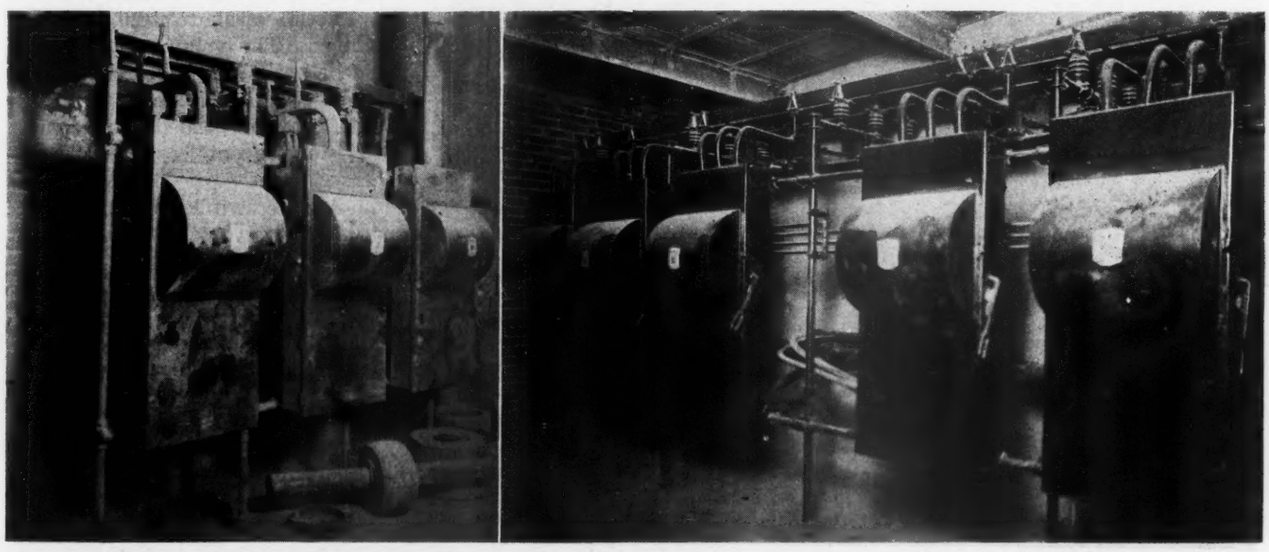
Standard enclosed safety switches of 400-amp. or 600-amp. capacity are mounted on panels supported on a strong, simple pipe framework. The busbars are supported on pipe-mounted bus insulators at the top of the framework. When desired a panel for one or more watt-hour meters may easily be attached to the framework. Switchboard-type current transformers may be mounted in the leads between the bus and the switches, or a bus-type transformer may be inserted at the end of the bus in order to meter the entire distribution center. The circuits are divided, (1) according to the metering necessary and, (2) so that no circuit will be loaded beyond the capacity of a 600-amp. switch. Whenever the load on a circuit exceeds this value a section of bus is put in and a new circuit is run to take care of the additional load.

door and latch was desired which would resist the explosive action of a short-circuit in the switch and not blow open, exposing the operator to the hot escaping gases. A quick-make-and-break attachment was considered necessary to prevent arc-overs when the switch was thrown in with a compensator left in the running position, and to prevent an operator from jogging a small motor with the knife switches. Several devices were developed in the field for attachment to the existing switches in order to keep the door shut when the switch was in and to prevent closing the switch while the door was open. This was done during the years 1918 to 1921. By the latter year the manufacturers of safety switches, having realized the need of the industries for greater safety in operation, had provided safety switches embodying in varying degrees the protection desired.

The writer has always used a compensator type of fused switch with compensators, 60 amp. being the smallest switch used for this purpose. Before reviewing the protection desirable in a safety switch the condi-

Fig. 3—Distribution panels like these combine simplicity and strength with ease of making additions and replacements.

The buses at the top are supported on pipe-mounted bus insulators. The illustration at the left shows a small panel consisting of three 500-volt, 600-amp., enclosed safety switches. The two switches at the left supply 10-40 hp. individual motor drives on grinding mills. The switch on the right is for disconnecting the overhead bus from one source of energy. The bus can also be fed from an emergency source controlled elsewhere. Both lines feed through the same current transformers located back of the right-hand switch. The illustration at the right shows five of six switches arranged as a distribution panel. The switches are rated at 500 volts, 600 amp. and supply six department or group feeders. A feeder from the power house supplies the overhead bus.



tions to be met in the industry must be analyzed. Where processes must be continuous and where shutdowns without warning involve serious loss, as in the chemical and allied industries, provision must be made for protecting material in process rather than have frequent stopping of motors due to a close margin of overload protection. Pumps and other equipment handling solids suspended in liquids should not be stopped instantly except in cases of short-circuits in the motor or wiring which might cause an interruption to the building circuit or where an overload indicates that the production machinery would be damaged seriously. Where overloads are due to bearing trouble and mechanical friction or disarrangement of the drive the motors must be operated under heavy overloads until that immediate part of the system can be cleared of material and the drive shut down.

With this requirement in mind, fuse protection is used at the motor, owing to the fact that corrosion under some conditions renders overload relays inoperative and because of the dangers attending a "double ground" between the middle wires of two different drives when on different phases, whereby the main building fuses will be blown. Building or department circuits are subdivided at the load-center distribution transformer banks, so that the maximum load on any one circuit will be within the capacity of a 600-amp. fused switch. These fuses protect the wiring between the distribution point and the motor fuses. The transformers and feeder cables are protected at the power station bus by automatic oil switches controlled by Westinghouse CO time-limit relays.

The operating conditions in industrial plants are of necessity reflected in the design of all electrical equipment. Where chemicals in the form of liquids, vapor and solids are handled a certain quantity will get into the switches and equipment. Where steam is present high humidity results and during cold weather all metal and insulating parts are saturated with water and conducting chemicals. In such cases the selection of switches must involve due consideration and tests in the field as to what will happen under operating conditions. The writer has found that under severe conditions a long leakage path from live switch parts to ground is necessary on 440-volt, and desirable on 220-volt, service. The leakage current to ground is able to evaporate the conducting fluids, dry off the insulation and thereby stop the flow of current. The insulation must be such that it will not be affected by the local heat and will not char or carbonize, leaving a low-resistance path. The operating mechanism of the switch should be able to resist corrosion to a certain extent and be arranged so that the moving parts will not have large moving surfaces against stationary surfaces where corrosion could cause a locking action. The general wiring arrangement should be such that any one switch in a group may be removed and replaced without disturbing other switches.

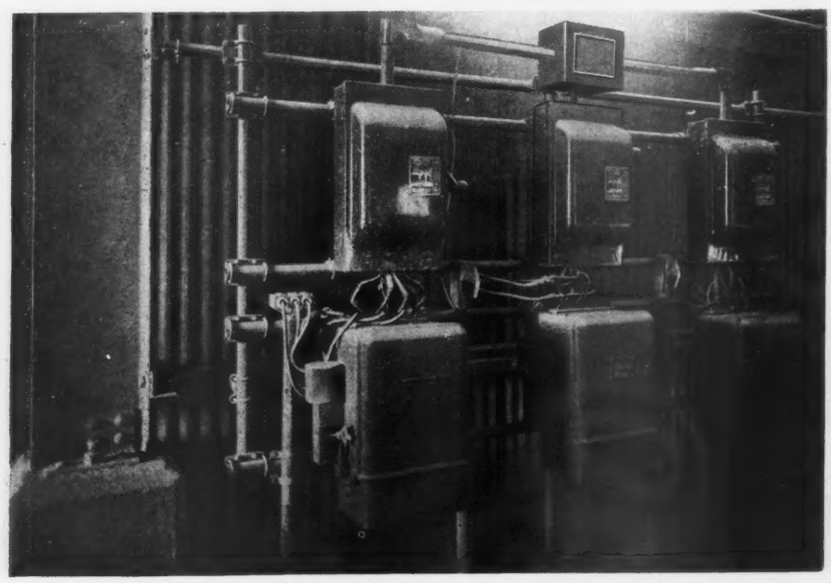


Fig. 4—These switches and compensators control motors which drive induced draft fans for the drying kilns.

The switches are rated at 60 amp., 500 volts and the compensators at 25 hp. In order to save time for the operator in going from one motor to another when starting up or stopping, the switches are grouped and located so that all of the motors are in sight. The construction of the supporting framework is shown clearly in this illustration.

Ten Essential Requirements for Safety Switches

After installing and operating about 2,000 safety switches of various types the writer would suggest the following ten requirements which safety switches for use under severe operating conditions should possess:

(1) The enclosing box should be of heavy gage sheet and should be capable of remaining in alignment over a long period of time.

(2) Latching devices, hinges and operating devices should be strong and rugged. Many switches on the market could well be of more substantial construction.

(3) The operating mechanism should be designed so that corrosion cannot cause binding and failure to operate for that reason. Broad metal surfaces rubbing against each other should be avoided in the design.

(4) A quick-make-and-break mechanism is essential. Operation of the switch should be possible even with all spring parts broken. The switch should be capable of being forced closed in case pitted or dirty contacts prevent the quick-make spring from throwing the blades in full contact.

(5) The method of insulating the crossbar of the operating mechanism and the type of insulation used should be of the highest order. The crossbar should be substantially fastened to the switch blades. The clearance between live switch parts and exposed metal in the switchbox should be as large as possible.

(6) The door latch device should be especially strong to resist the explosive action of short-circuits in the switchbox. The volume of the box should be such as to allow expansion of gases developed, and the box should not be sealed sufficiently tightly to prevent easy escape of the gases.

(7) A slate switch base should be used, affording a relatively long leakage path from live parts to ground. If the distance is short an arc is developed where excessive moisture or chemicals are present; a long leakage path allows the current to dry off the slate base.

(8) The entire switch element with base should be removable from the front of the box without dismantling the enclosing box.

(Please turn to page 161)

Some of the

Changes That Have Taken Place in Bearings

Beginning With the Primitive Devices Used by the Ancients and Including the Developments in Sleeve, Ball, and Roller Bearings Up to the Present Day

By L. A. HILLMAN

Research Engineer, Strom Ball Bearing Mfg. Company, Chicago, Ill.

BEARINGS ARE SO commonplace in our everyday life that it is very easy to overlook their importance and not appreciate just how much we are dependent on them. From the time we arise in the morning until we retire at night, we are continuously dependent on them, not only in our business activities but our personal ones as well. Taken in the order of their adoption, bearings are usually divided into three classes or groups: namely, sleeve, roller and ball. This article, which is an abstract of an address delivered by Mr. Hillman before a joint meeting of the Chicago section of the American Society of Mechanical Engineers and the Western Society of Engineers, presents the evolution of each of the three types of bearings. At this meeting there were also two other articles presented on roller and sleeve bearings. These articles together with the discussion developed at the meeting were reported in the January issue of INDUSTRIAL ENGINEER.

LOOKING back and reviewing briefly the early stages of civilization, we find recorded as early as 3,500 B. C. a simple form of plain bearing in a wheel, the latter probably being a slice of a tree trunk with a hole in the center. Later the design was brought more nearly to our present standard by the introduction of spokes, so that in 2,000 B. C. we find war chariots equipped with wheels having a hub, spokes and outer rim.

In all probability both members of these early bearings were made of wood. The next step, although the definite date is not available, was undoubtedly the use of iron for at least one, and possibly both members of the bearing.

With the advent of steel, iron boxes and steel shafts came into common use and for years no attempt was made to improve on this combination, which served admirably for the operating conditions in those early days.

In 1839 Babbitt patented a bearing metal, which still bears his name, made of copper, tin and antimony. The development of plain bearings from then on is more or less familiar to all of you; so we can pass to the next in order of adoption; namely, roller bearings.

Before leaving the subject I want to touch briefly on one recent departure from the old school in connection with plain bearings, which I feel is a very decided step in the right direction. I refer to the rapidly growing tendency to provide perfectly fitted bearing surfaces having the correct clearance at the start through the medium of lapped shafts and burnished bearings, both finished to a high degree. This is a decided contrast to the old method of scraping the bearing to the shaft, fitting it tight at the start and depending on the wearing down of the high spots to provide the proper fit and clearance.

In the early ages masses that were too heavy to carry were transported on sledges or runners—a method we still find in use today among primitive tribes. An ancient Egyptian painting on the rocks of El Bersheh (about 1,900 B. C.) shows this method of transporting a large stone statue. In this picture a man is shown pouring out lubricant in front of the sledge. The ancients not only realized the necessity of lubrication but depicted it in their carvings for the benefit of those who were to follow. A great many users of bearings today would do well to take a tip from the ancients and give more attention to proper lubrication.

It is easy for us to conceive the next step: namely, interposing roll-

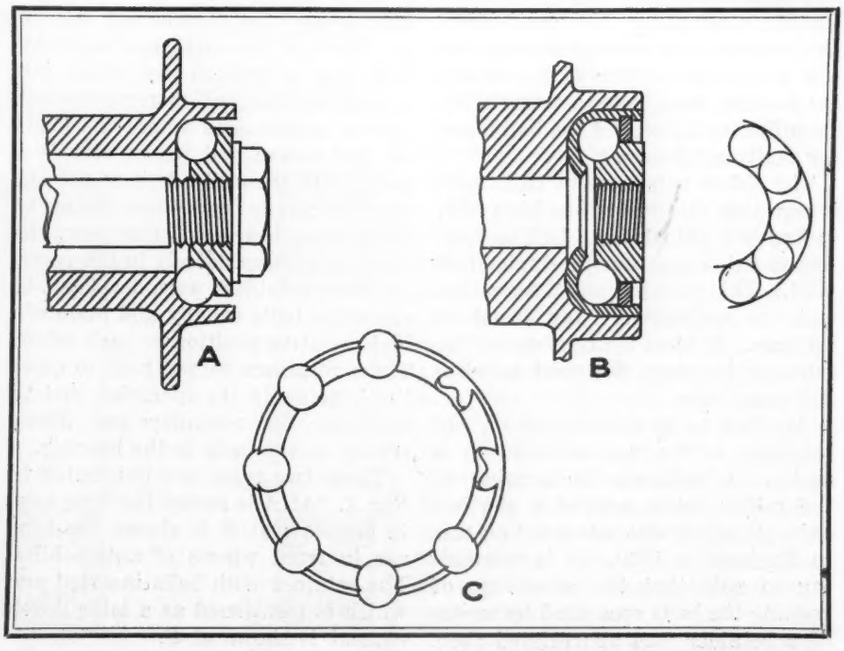


Fig. 1—Cup-and-cone bearings represent an early stage in the development of ball bearings.

At *A* is shown the type used in bicycles, about 1890. At *B* is shown the type first used in the front wheels of automobiles. For years the balls were placed loosely in the races as shown at the right of *B*, but later the retainer shown at *C* was developed to space the balls equally. This quieted the operation of the bearing.

ers, probably made of tree trunks or limbs, between the ground and the skids. A carving found on rocks in Assyria (875 B. C.) shows how the ancients moved a large statue by using rollers. A large number of rollers were used, showing that the advantages of distributing the load over the greatest area was appreciated even in those early days. Roman battering-rams were moved on rollers in 50 B. C. It is interesting to note that the ancients appreciated the necessity of maintaining a space between the rollers and holding them in alignment—something the later makers of ball and roller bearings were forced to learn over again.

You are all familiar with the rolling device used on sliding doors where a roller runs along a track equal in length to the width of the door, while a pin at the center of the roller travels a track possibly a foot or so in length. This same device was used as a speed reducing device made in 1500 A. D.

As in the case of the plain bearings, although the principles of rollers were understood and their advantages appreciated, they were used only in crude ways until the latter part of the 19th century when demand brought about their further refinement and development.

We find no reference to ball bearings in the early ages of civilization. Even though their advantages may have been appreciated, the early workmen were probably confronted with the same problem which perplexed the experimenters in the 18th and 19th centuries: namely, that of making steel balls. Not until Hoffman developed a process during the last few years of the 19th century for making steel balls to remarkably close limits of size, did the ball bearing really get its start.

The oldest reference to ball bearings which the writer has been able to find is a patent for a ball-bearing wagon axle taken out in England in 1794. This is especially interesting and was undoubtedly far ahead of its time. It is in many respects the same as bearings designed as ideal 100 years later.

Another early application of ball bearings is the use of balls in a caster, to facilitate the turning of the caster roller around a vertical axis. A patent was taken out on this in England in 1820. It is interesting to note that the advantage of keeping the balls separated by means of a retainer was appreciated then.

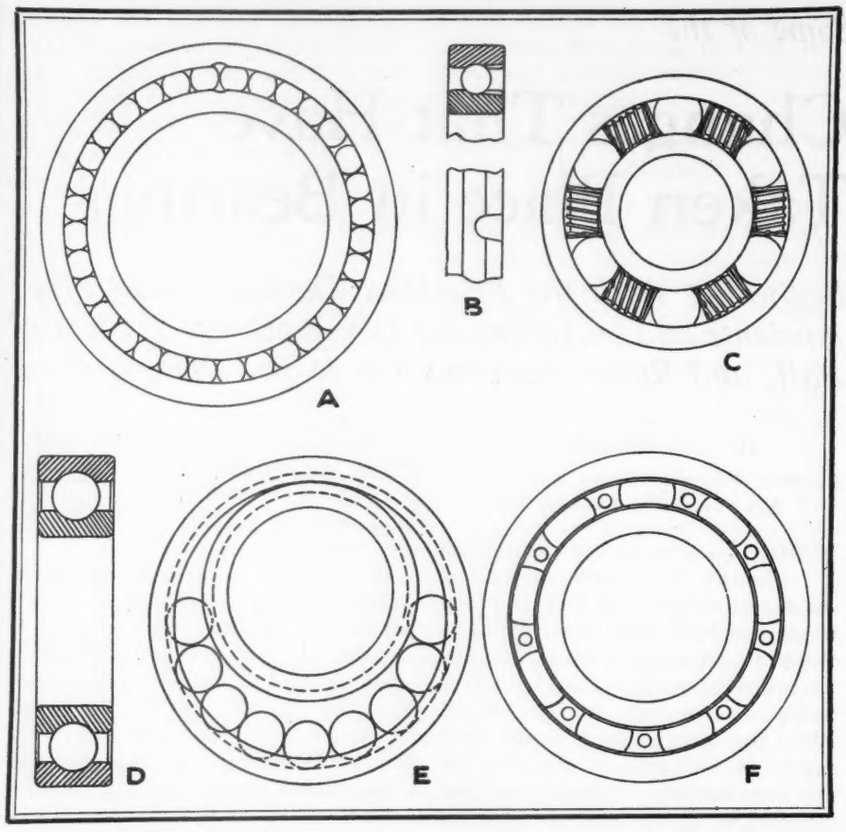


Fig. 2—Full-type, spring-type, and Conrad-type bearings.
At *A* is shown a full-type ball bearing. Only a very small clearance was left between the balls to prevent them from crowding and locking the bearing. The balls were assembled in the race through the filling slot shown at the top of the bearing. Details of the filling slot are shown at *B*. At *C* is shown a ball bearing having a spring-type separator. *D*, *E*, and *F*, show the type of separator used in the Conrad type of ball bearing. At *E* is shown the method of putting the balls in the raceway.

The next step in the development of ball bearings came soon after the invention of the bicycle and was in the form of cup-and-cone bearings. This type is still in use today, not only in bicycles and motorcycles but also in applications where the loads are not severe and where cost is a factor. In the early days of the automobile many cars used them as front wheel bearings. For years the balls were placed loosely in the races, but later retainers were developed to space the balls equally and maintain their relative position to each other. These retainers served both to quiet the bearing in its operation and to facilitate the assembly and disassembly of the balls in the bearing.

These two types are illustrated in Fig. 1. At *A* is shown the type used in bicycles; at *B* is shown the type use in front wheels of automobiles. The retainer with balls inserted and which is mentioned as a later development is shown at *C*.

Properly designed, installed and cared for, they served their purpose admirably. The one outstanding disadvantage is the fact that they are adjustable. Because of this their reputation suffered at the hands of those who did not understand their proper adjustment.

Difficulty was also encountered because of the fact that proper steel from which to make the bearings was not available in the early days and it was also necessary to keep their costs down in order to compete with plain bearings.

The first use of ball bearings in bicycles was in the early 90's and as heretofore stated, these bearings were of the cup-and-cone type. The bearings were amply large for the service imposed and the results obtained contrasted so favorably with those experienced with plain bearings that immediately attempts were made to apply the same design to other and heavier forms of service, such as the wheels of heavy trucks, drays, and the like. Results were far from encouraging—some applications worked fairly well; some were utter failures.

Fortunately, the failures were analyzed as being due to improper materials and design, and not to the basic principles involved; so that instead of dropping the problem as hopeless, those of vision set about

correcting the faults and attaining success.

Hoffman went to England where he interested capital in the manufacture of balls and it was evident from the results obtained that balls of good quality and a high degree of accuracy could be made.

In 1896 the German Small Arms & Ammunition Co. employed Professor Striebeck to investigate the subject of ball bearings, as they had decided to go into the manufacture of balls and ball bearings.

Professor Striebeck's work really marks the start of ball bearings as we know them today and much of their success is due to the fact that he did the task assigned to him with characteristic thoroughness. Many of his deductions have proven to be sound and still hold good today.

The first bearings were of the full type, so called because the races were entirely filled with balls, a small clearance being left as shown at *A* of Fig. 2, so as to prevent the balls from crowding and locking the bearing. The balls were assembled between the races by means of a filling slot shown at the top of the race. This slot was ground not quite to the center of the ball track so that the slight shoulder over which the balls had to be forced served to prevent them from coming out when the bearing was in operation, or if the bearing should be mounted on a vertical shaft with the slot opening downward.

This type of bearing was manufactured by several companies for years and gave reasonably satisfactory service. Some bearings were made with a piece of steel inlaid in the filling slot and held in by means of a screw, for it was found that after the bearings wore in service there was a tendency for the balls to drop out of the filling slot. This scheme was soon discarded, however.

The full-type bearings, aside from the filling slot objection, had several other disadvantages. Since there was a slight space between the balls the bearing was noisy in operation for the same reason as was the cup-and-cone bearing, as has been previously explained. This was particularly true if the lubricant was of a thin grade. Since the balls were traveling in opposite directions at the points where they came in contact with each other, flats or equators were worn around their circumference after which they were unfit for satisfactory operation.

Although it was appreciated that to provide a means to prevent the balls from coming in contact with each other, meant a few less balls and therefore a sacrifice of some capacity, the demand for a silent and more satisfactory type of bearing prevailed and various means were adopted to space or separate the balls equally around the race.

It would be out of the question to cover all the types and kinds of separators developed and it is probably unnecessary to discuss them as only a few have survived.

One of the earlier types was the spring type shown at *C* of Fig. 2. This was finally discarded because after the tension of the springs weakened there was a tendency for them to drop out of the bearing and either allow the bearing to collapse, or else the springs lodged in some of the other parts of the mechanism, such as gears, and caused damage.

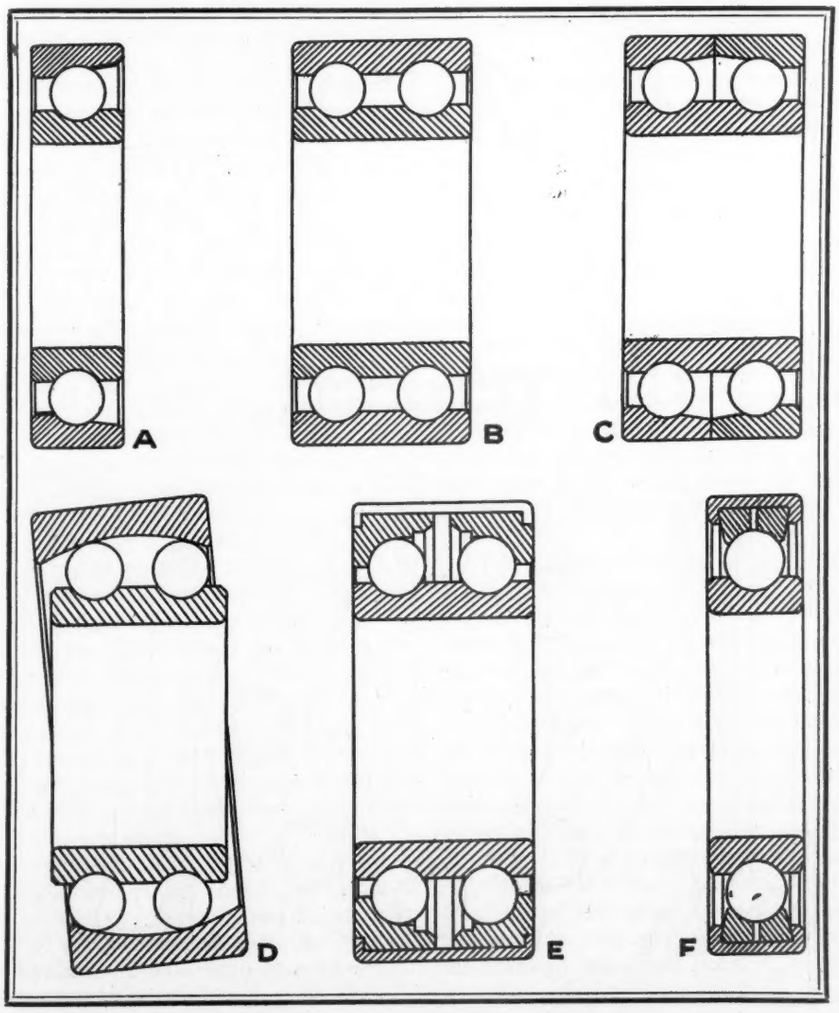
Finally, cast bronze or sheet metal retainers were developed which were of unit construction and which, in addition to spacing the balls, had the added advantage of preventing the balls from dropping out of the filling slot.

The Conrad type of bearing patented in 1906 and 1907 is worthy of consideration because it is the best all-purpose radial bearing as yet developed. The patent covered a bearing in which the inner and outer races were uninterrupted in any way and were of the same cross section throughout. It also covered the method of assembling the bearing. This bearing is shown at *D*, *E* and *F* of Fig. 2. The quantity of balls used was just enough to fill half of the raceway when the balls were placed in the raceway in contact with each other.

To assemble the bearing the outer and inner races were placed in the

Fig. 3—Angular-contact type of bearing and types of bearings having patented features.

At *A*, *B*, and *C* are shown angular-contact type, ball bearings. *D* is a self-aligning type which permits of a considerable degree of misalignment of the shaft. *F* is a single-row bearing with a 2-piece outer race retained by a soft steel shell spun in place. *E* is a double-row bearing in which the outer race is made in two sections and held in place with a soft steel shell spun down on the sides. The bearings shown at *E* and *F* have 3-point contact of the balls and races.



position shown at *E* of Fig. 2 and the balls put in through the opening at the bottom. The inner race was then placed concentric with the outer and the balls equally spaced. The retainer was then assembled the same as in any other type.

Although it appears that the carrying capacity of this bearing will be greatly lessened by the considerable decrease in the number of balls, as compared with the filling-slot type, this decrease in capacity is not exactly in direct proportion because the uninterrupted raceways of the Conrad type add decidedly to its ability to carry loads. Thrust loads in addition to radial are often carried on radial bearings and in the type with the filling slot, this causes ball interference with the edges of the filling slots, resulting in noisy operation and failure. These difficulties are not encountered in the Conrad type because of the uninterrupted races that are provided for the balls to travel in.

So today we have as survivors of the development of radial ball bearings, the cup-and-cone type, the full type, the notched type with retainer and the Conrad type, all of which have been explained. In addition we have the angular-contact type shown at *A*, *B* and *C* of Fig. 3, which is nothing more than a modification of the cup and cone—some designs are made so they are readily disassembled; others are held together by means of a slight shoulder. Practically all of these are made in double row as well as single row types.

There are a few types with patented features. The first is a self-aligning type shown at *D* of Fig. 3, which permits of a considerable degree of misalignment of the shaft with the frame supporting the outer race of the bearing.

At *F*, Fig. 3, is a type of single row bearing with a 2-piece outer race held in place by a soft steel shell spun in place. This type has 3-point contact of the balls and races, one on the inner and two on the outer race.

At *E*, Fig. 3, is shown another type made only in the double row, in which the outer race is made in two sections and held in place with a soft steel shell that is spun down on the sides of the races.

Early ball thrust bearings were made of two hardened steel plates with surfaces ground flat. The balls were held in proper position by means of a retainer. This type is still in use today where the loads are light and where an inexpensive bearing is required.

The first retainers were so designed that the balls tracked in one single path. As this threw all the load on a very small area of the races, retainers as shown at *A*, *B*, and *D* of Fig. 4 were resorted to in order to distribute the area of contact as much as possible over the face of the race.

It soon became evident that even with the new retainer, designs of the flat-disc type were not satisfactory for carrying heavy loads, especially at the higher speeds. So the next step was the grooved type. Many different kinds and types of retainers have been devised for use with this type of thrust bearing, but a pressed-steel type of the design shown at *E* of Fig. 4 seems to have proven the most satisfactory.

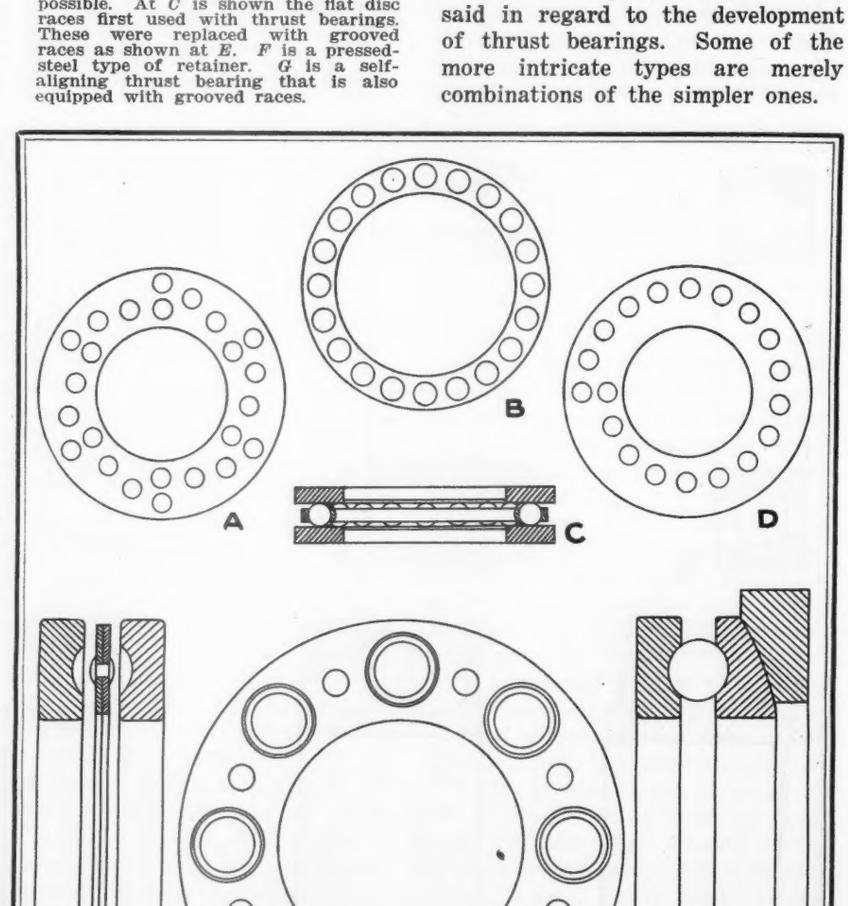
Another source of difficulty with the early thrust bearings was traced to misalignment of the parts in which the bearings were mounted. One can readily see that in order to have the load equally distributed on all the balls at all times in a bearing such as shown, not only must the two outer surfaces of the bearing be parallel but the parts in contact with them as well.

In order to overcome this troublesome feature, the outer surface of one race of the bearing was made spherical as shown at *G* in Fig. 4. In most cases the manufacturer supplied an extra ring or seat which eliminated the necessity of the user turning a spherical seat in the part where the bearing was to be mounted.

There is very little further to be said in regard to the development of thrust bearings. Some of the more intricate types are merely combinations of the simpler ones.

Fig. 4—The ball retainers for thrust bearings were first designed so that the balls tracked in a single path.

As this threw the load on a very small area of the race, the retainers shown at *A*, *B* and *D* were designed to distribute the area of contact as much as possible. At *C* is shown the flat disc races first used with thrust bearings. These were replaced with grooved races as shown at *E*. *F* is a pressed-steel type of retainer. *G* is a self-aligning thrust bearing that is also equipped with grooved races.



Things the equipment inspector for a manufacturer looks for and some of those that he finds

* * *

Assured that he is going on a still hunt for trouble, where and how will he find it?

* * *

His advice from the Boss is—Remember that 90 per cent of electrical trouble is mechanical—Beware of simplicity in looking for trouble—Be an engineer first, but a diplomat always

Reminiscences of a Trouble Shooter for a Machinery Builder

Sketches from an interview by

Practical Pete

I HAVE a friend, who is an erecting engineer with a large machinery builder, whose knowledge I respect and whose experience I truly envy. He just knows what he knows and the best of it is that he is anything but tight with his information. Furthermore, he knows how to impart it in a way that is easy to understand. To listen to him relate his tales of woe today and of bygone years places you in that frame of mind where you can picture some fast stepping around just where that action is required and a scowl and that "mind your own business" look when the inquisitive guy butts in with foolish questions at the wrong time, which time is usually a period of deep thought and apparent concentration over a blueprint that is all wrong.

Recently I got hold of this fellow whom we will call "Ed" for short and got him started on some memorable experiences and we sat, as many of you have done when you meet a real trouble shooter, and just "chewed the rag" over the worst jobs we ever tackled, and the things that were bumped into without intention, also sometimes with intentions and some doubts and guesses that were carefully concealed.

What Ed told me was so good in spots and places that I am going to set it down here as best I can from the notes that were taken as he went along from one thing to another.

In the beginning, as a starter I said, "Ed, tell me some of the things you look for when performing in the role of inspector, and some of the things you have found."

"Well," said Ed, "it has been my pleasure to have been on both the inspector and inspected ends of such a detail. Before becoming an inspector and being confined strictly to the inspected end, I often wondered what information these men looked for. Now I know. For the benefit of those who may be in the wondering state of mind still, I will be glad to relate a few experiences of my own as an inspector for a manufacturer.

"For instance, I recently came in from an inspection job which had to do with the change-over from direct current to alternating current and the consequent sale of the direct-current apparatus, including switchboards, buses, generators, and all the necessary apparatus that was installed in a substantial, direct-current generating station. This apparatus had been in service for nearly 12 years. The purchase price I do not know. Whether it was a small fraction of the original cost or the present-day cost, was immaterial to me from an inspection point of view, but I did know that about 1,500 miles away was a buyer who knew that this apparatus had been in active service for nearly 12 years and if he was in any sense of the word a practical man, he could build all kinds of illusions as to the condition his purchase might be in.

"An inspector must keep many things in mind on such a trip. In this particular place the firm selling the material was our customer. The purchaser had no connection with us. A biased report favorable to our customer would make us responsible for defective machinery and also lose

WHEN MAKING REPAIRS or replacements it is often necessary to have some apparatus, part of a machine or even a whole plant, inspected by a competent engineer from the manufacturer's engineering department. The fellow who is assigned to such work has no easy job, for he must be a good engineer, first, a man with practical experience, second, and a good-natured diplomat all the time. He must listen and say nothing sometimes and say nothing and be deaf at others. But never can he give up on a job and say he's stuck. He may go back to his works for additional blueprints or special instruments but his self-respect and his confidence to do the job must never permit him to leave a job until it is operating free from the troubles he was called to investigate. The things that I have related in this article are no fairy tales; they have actually happened just as set down and been handled by a real trouble man who meets all the qualifications above enumerated. To those who have a perfectly good reason to want it, I shall be glad to furnish the address of this troubleman, but for the time being he is just my good friend who has told me these things in confidence and for the benefit of those who are in a position to profit by the information. If it bores anyone else they don't have to read it. Moreover, if it steps on the toes of any one, they don't have to holler nor tell who they are.

the possibility of securing the second party as a customer in the future. On the other hand, should the machinery be in such condition that an unfavorable report would be necessary, the inspecting engineer would have to be very tactful lest the actual customer and the prospective customer be lost. In all events, it is better that the inspecting engineer be as ignorant as possible of the monetary considerations and confine himself to engineering only—unless diplomacy can be considered within the scope of our profession."

"I have never been on the inspecting end," I told him, "but always on the inspected end, as you call it, and I know that you people who have something to sell sometimes run up against some tough customers. Tell me something about the kind of reception you get when you arrive on the job."

Then with a twinkle in his bright eyes, Ed started in: "You know, that old quotation of school days occurs to me now and if my memory serves me correctly, it goes as follows: 'Methinks the gentleman explains too much'—leastwise that is the application I mean it to imply. And how well it applies to contact with people who have something to sell, especially those who are particularly desirous of making a sale and more especially to those who would like to get the better of the bargain.

"One type of customer friend meets us at the train, takes us to the hotel, then to his office and from that time until we leave he or his lieutenants are right with us to explain this or explain that, or as the case may be, to condemn this or that as the occasion demands. It is mostly praise and take it from me, they do it to perfection, but the engineer makes his report notwithstanding. Then we meet another type of customer friend who extends a friendly greeting, chats a bit and then goes about his business, either to show us the apparatus in question or turns us over to his lieutenants with instructions to assist us all they can or with no word to them at all, if he believes them capable of assuming their responsibilities.

"From this you may assume that there are two kinds of persons and they are the ones that I have listed above. In the first case the person may turn out to be a real, good, likeable chap who has a misconceived notion as to helping in lending a hand, while the second may assume his rather distinguished business air and then have a nicely prearranged schedule to get something on the inspector to cause his report to be erroneous.

"Now, an engineer is human and is likely to err, but not to my knowledge have I met, or do I know, a competent engineer who would make a biased report. In the first place, a good engineer would place his engineering ability above anything that would at some future date be of hindrance to his ambition and, besides, I think all of us possess that little spark of celestial fire called 'Conscience'. But errors are still liable to creep in and my purpose in mentioning this is to point out that if an error is made, it can in all probability be charged to an oversight in the great majority of cases; to lack of engineering ability in the second place; and last, but not the least, to misleading items that have caused a poor report. The last can be charged to the engineer. Generally speaking, engineers representing a manufacturer are men with good, practical engineering ability, capable and self-reliant. They have a good understanding of human nature and are four-square."

"Besides the operating conditions and facts you find, what else do you think an inspector should include in his report?" I asked.

"I am glad you mentioned that," Ed replied, "and I can best answer the question by again referring to the things I ran into on the particular job already mentioned. When I was called in to make that inspection I was greeted as one gentleman would greet another, given a pass to go anywhere in the works, told from whom I might obtain particular information and where I might find these persons. To make errors less liable the names were written on the pass and I was further instructed to get about the huge plant without getting in all the dirt.

"The master mechanic was found in the building I was directed to and after giving introductions to a part of his immediate force, he located the chief electrician and in the *unobtrusive* company of these two gentlemen, a complete inspection was made.

"As stated before, these units were in active service nearly 12 years; sometimes (as explained by the chief) as long as four months without a shutdown, and the condition I found them in was just as they had been shut down about six months previously when the plant was changed to alternating current. The equipment was dirty in many respects—a dirt that could easily have been cleaned off since the units were last shut down—but underneath were signs that indicated that the exterior where operating cleaning was possible, was not a sham. In other words, it showed all care and consideration that could possibly be given a continuously-operating piece of machinery.

"The commutators were in excellent condition, turned twice, brushes accurately fitted and showing signs of good service, bearings had 0.010 in. clearance on the original set, with a good, clear oil coming from them, foundation good, all bases and pedestals securely bolted and shimmed, switchpoints, busbars and other movable contacts not burned, in clean condition, etc.

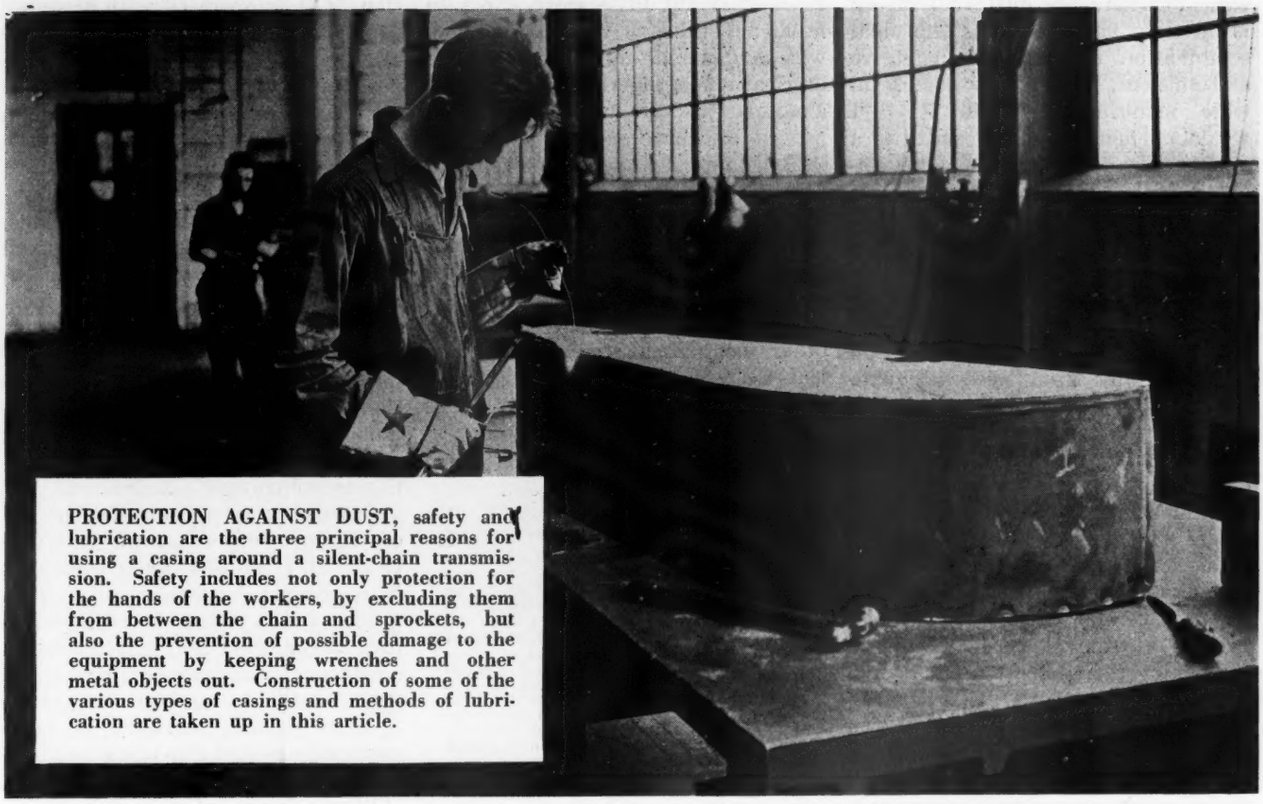
"The above indicates that a further account of this would be monotonous, for other equipment and parts were as indicated in the foregoing, just as the units were shut down and no attempt made in word or work to make the machinery appear to be anything other than it was: namely, good machinery that had given good service, the kind of service the engineers did not like to part with.

"Let us now look behind the scenes, as the inspector always does. Here was the master mechanic in his place; the chief electrician about his business, but easily called. Both of them were confident and capable-appearing men. A talk with their operators disclosed the fact that they had been in their positions for a number of years. A trip about the works showed that everything seemed to be in its place, machinery operating satisfactorily with minimum noise and apparently repairs were well made by understanding workmen. Harmony and satisfaction seemed to be the predominant factor in men and machines and this was borne out by the mute testimony of the apparatus that they had for sale. Could one believe the machine's appearance if anything but harmony was apparent? And is not this information worth just as much in an inspection report as cold engineering data and conditions as found?"

"But all the plants you inspect are far from that condition, I imagine from what I have seen," I interjected.

"You are dead right," said Ed.

(*Please turn to page 161*)



PROTECTION AGAINST DUST, safety and lubrication are the three principal reasons for using a casing around a silent-chain transmission. Safety includes not only protection for the hands of the workers, by excluding them from between the chain and sprockets, but also the prevention of possible damage to the equipment by keeping wrenches and other metal objects out. Construction of some of the various types of casings and methods of lubrication are taken up in this article.

The casing is built up here by welding the corners with the oxyacetylene flame torch. It is not necessary to use angle iron to strengthen the casing, if it is properly welded.

Practical Methods of

Enclosing and Lubricating Silent Chain Drives

To Obtain Long Life and Continuous Operation With a Minimum of Attention When Installed in Industrial Plants for Connecting Motors to Machines or Lineshafts

By PAUL WHEELER

Engineer, Link-Belt Co., Cleveland, Ohio

WHEN considering the installation of a new power transmission system or the replacement of an existing one, silent-chain drives possess qualities that merit consideration. Silent-chain drives were originally designed for power transmission where neither belts nor meshed gears were practicable. However, they have completely outgrown this limitation in industrial usage and are today employed in many plants for power transmission service.

During the period of development, however, silent-chain drives were not installed where excessively abrasive atmospheric conditions were encountered, such as in clay-working plants, cement mills and other similar industries, until the universal application of the drives had been proven. The result was the slow recognition of the necessity of dust-proof, oil-tight casings for the drives when used under such conditions. However, the necessity for such a casing is frequently underestimated by users who have in many cases failed to enclose the drive in a casing when the installation was to be made in a grain elevator, cement mill, brick plant or other unusually dusty place.

There are three underlying reasons why users of silent-chain drives should insist on proper casings for this type of power transmission equipment. These reasons are: (1) To keep out dust; (2) to retain oil; (3) to increase safety.

The reason why it is necessary to keep out dust is obvious. Under many industrial conditions, the air is filled with hard, gritty and abrasive dust. Its action might be likened to an abrasive compound mixed with a little oil. This dust proves very destructive to the chain and causes cutting into the joints, side cutting of the links and occasionally causes the pin to protrude. This latter occurrence is often spoken of as the "lengthening of the pin" by users who are not familiar with the cause.

The necessity of using a casing to retain the lubricant is equally obvious, and equally important. Silent-chain transmission requires lubrication. This can be accomplished by either periodic applications with a brush, or by the use of an oil bath into which the chain dips at all times. The latter is by far the better method and is a safeguard against neglect. If properly made of substantial material and with

welded corners, the dustproof casing is oil tight as well. It is this dual combination that is most effective and efficient. As a very successful Ohio manufacturer puts it: "I would no more think of putting a silent-chain drive in my plant without a real casing than I would attempt to wear my Waltham watch without the casing provided for its works."

The third factor, which is equally as important as the other factors, is that of safety. Open transmission units of any kind need adequate guarding to prevent injury to hands or other parts of the body. Oilers in particular need protection because they frequently work from ladders or in places difficult of access, where a slip might be serious or even fatal. Also, there is the possibility of a chain or belt breaking and causing damage or injury. Adequate and proper safeguards prevent accidents by making them impossible. Also, it must be remembered that guards which will keep fingers out, will also prevent wrenches, oil cans, bolts, nuts or other loose pieces of metal, which might cause serious damage, from getting in between the chain and toothed wheels. Many state and industrial insurance company codes require such safeguarding. In such cases it is but little more effort to build an enclosing safeguard which will also exclude dust and facilitate lubrication. Properly-guarded silent chains are as safe as other means of power transmission.

Some mechanical engineers hold that a silent-chain drive can be operated without oil. Salesmen are frequently asked: "Can your silent chains operate without oil?" Certainly; but it is a principle of practical mechanics that any chain or other moving part will run better, last longer and require less attention, if it is operated with a proper supply of oil, in a dustproof, oil-retaining casing, than if it operates exposed and with little or no oil. All air contains some suspended dust, particles of which eventually settle on a chain, particularly if the chain is oily.

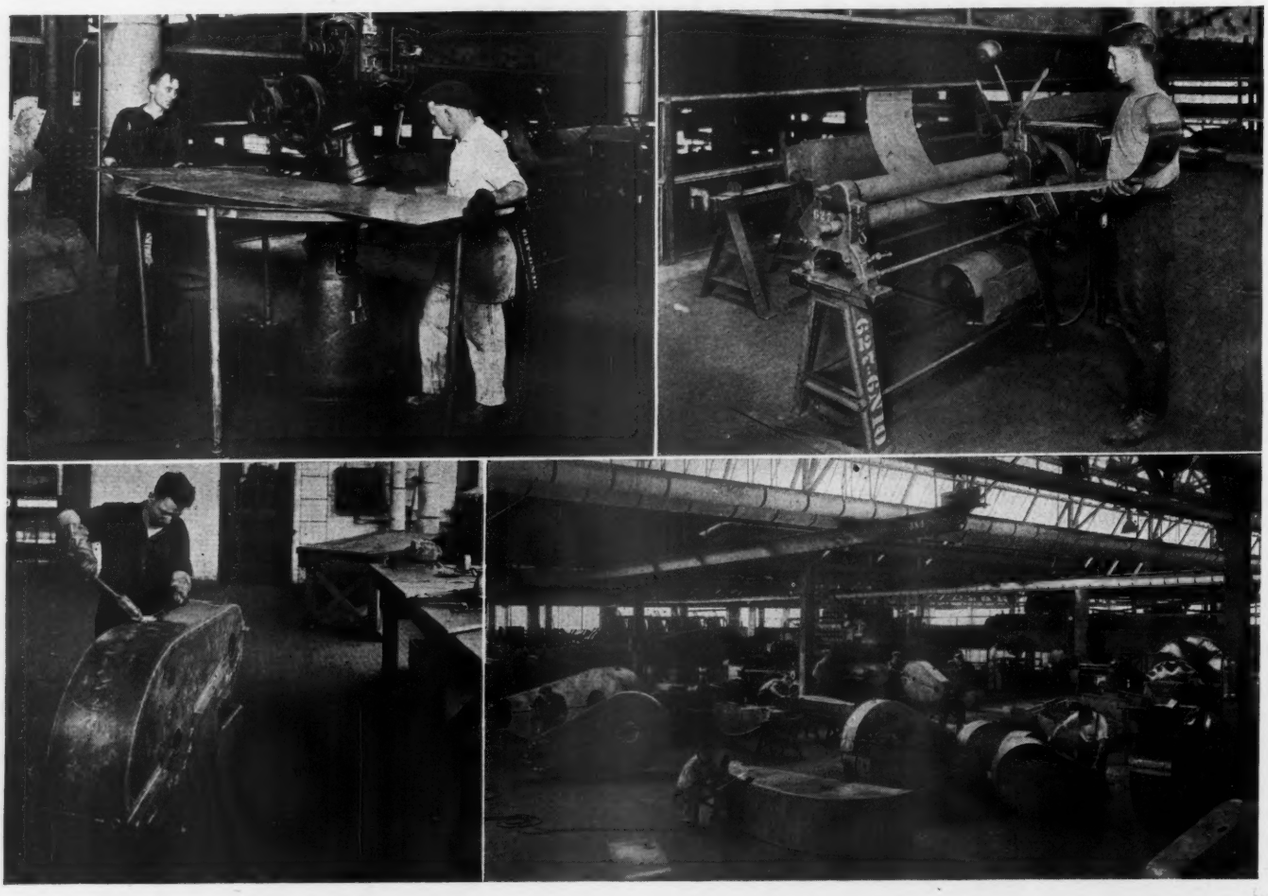
Silent chains, regardless of make, are composed of links and joints and usually operate at high speeds. Silent-chain drives are lubricated most satisfactorily when equipped with an oil-retaining and dust-tight casing, as assurance that such lubrication will be available at all times. Some of these casings and their method of construction are shown in the accompanying illustrations.

Ordinarily we recommend the use of Gargoyle drive-case oil for practically all types of installations. This is equivalent to 600-W oil. This grade of oil we have found satisfactory under practically any operating conditions of temperature or humidity. Dust-tight casings are relied upon to exclude moisture in damp surroundings and also abrasive material in dusty surroundings.

Where dustproof casings, made by the manufacturer of silent chains, are used the lubricant generally needs to be changed only about once a year. Under exceptional conditions

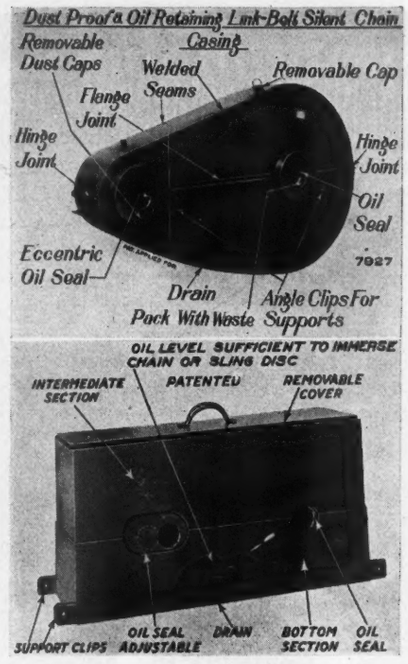
Four steps in the manufacture of a casing for a silent-chain drive in the Link-Belt Company shops.

The first step is obviously to lay out the casing according to its size and shape. This is determined by the distance between the center line of the driving and driven shafts, by the diameter of the sprockets plus the thickness of the chain installed plus the additional amount of clearance required as given in the text. The machine at the upper left shows a method of trimming pieces of sheet steel to a curved line. In case a shop does not have a machine of this kind, the gage of metal used is not so heavy but that it can be trimmed in other ways. Practically every industrial shop doing any metal work whatever has bending rolls similar to those shown in the illustration in the upper right. Here the operator is curving the center half of a casing. The lower right illustration shows how the inlet or inspection flange is soldered on by hand. The view in the lower right is of a general arrangement of the shop and shows the construction of a number of large and medium-sized chain casings.



it may be necessary to change the oil more frequently. Since the repair shop or sheet-metal shop of the average industrial plant does not have the equipment or the facilities for making casings as dustproof as does the manufacturer it is better to change the oil as frequently as every three months when home-made casings are installed. This is easily accomplished by draining off the old oil through the bottom drip plug and replenishing with new oil through the inspection slide or cap at the top. It is seldom necessary to use a light oil, such as gasoline, to wash out the casing. If it should be used it is not advisable to pour it on the chain as the light oil washes the lubricant out. Also, any light oil remaining in the casing dilutes the lubricant and so decreases its value.

The usual methods of lubrication are either by the splash system, in which the chain sprockets and chain are slightly submerged in oil, or by the use of a disc or sling, which throws the oil to the top of the casing from which it drips onto the chain. The former is usually used, but when the motor shaft is considerably lower than the driven shaft, the oil will pocket in the small end of the casing. In such cases, the disc type, as shown at the bottom of the page is used. It will be noted in this illustration that the disc automatically dips into the oil reservoir and throws the oil against a V-splash plate on the inside of the top. The oil drips down onto the chain and so provides a constantly uniform lubrication for as long time as the drive is in operation.



Two types of casings for use with silent-chains.

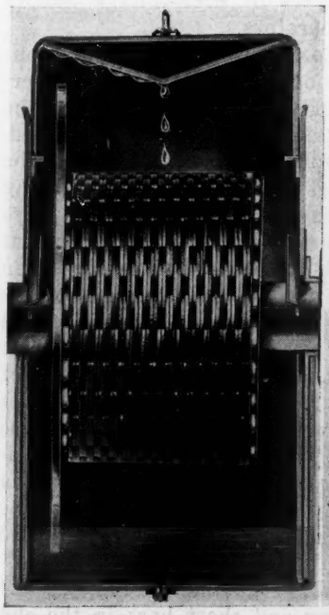
The general idea of how casings may be built up is shown from these two drawings and the cross-section view reproduced at the bottom of the page. By means of the adjustable oil seals, it is possible to take care of any slight vibration during operation. The method of lubrication by means of a sling disc is shown in the illustration at the bottom of the page. In other cases the chain dips into the lubricant during operation.

Casings, broadly speaking, are spoken of as either rigid or flexible according to the type of seal at the shaft openings. Those of the rigid type, as illustrated at the bottom of the page, are used mainly on fans, or where the load is smooth and there is little vibration. Casings of the flexible type, as shown at the top of the page, are more generally applied where there is a noticeable vibration. In either case these casings are equipped with an eccentric oil seal on the motor or driving ends, which permits of adjustment or motor take-up, without interfering with the casing supports, or losing its sealing feature around the driving or driven shafts.

These casings are of substantial material (about 12- or 14-gage, hot-rolled steel) with welded corners. It requires a rugged construction of this kind to successfully withstand the vibration and rough usage, and to prevent bulging and warping. There should be a greater insistance on the part of silent-chain users desiring casings, for those coverings which are ruggedly constructed. Only in case of necessity is it advisable to allow a local tinsmith or blacksmith to construct the casing, as he seldom has the ability, experience, or equipment to do the work properly. Also, it is difficult to get him to appreciate the importance of a good job. Poor casings have actually ruined an otherwise good chain drive installation.

However, the practices used by the Link-Belt Company in the construction of casings may be of value to an industrial plant which prefers to make its own. Ordinarily, we recommend ½-in. clearance in width on each side of the sprockets and from 3-in. to 7-in. clearance at the ends of the sprockets with chains attached. This varies according to the size of the casing constructed. The casings are constructed by breaking and bending the sheets and welding the corners, edges and drip-plug at the bottom and the inspection opening on the top. Angle iron is not necessary to form substantial corners; good welding will make the corners strong enough. Casings are made split so that they may be installed or removed easily. This makes their construction easier as they can be welded on the inside as well as on the outside of the seams at the corners.

Recognition of silent-chain drives in power transmission in industrial plants has come strictly on merit. However, such recognition would be all the more definite and well defined if the users of silent chain will properly enclose and lubricate their installations. This simple expedient will enable this type of transmission to give the maximum in service with the minimum in required attention and expense.



An example of the rigid type of casing and one method of lubrication.

Rigid-type casings are commonly used on fans and where the drive operates with little vibration. This casing is provided with an eccentric oil seal on the motor or driving end which permits of adjustment or motor take-up without interfering with the casing-support, or without losing the sealing feature at the shaft. The illustration at the left shows the construction of a casing. In this disc or sling type of lubrication the disc dips into the oil and throws it onto the cone-shaped section in the top of the casing from which the oil drips down on to the chain.

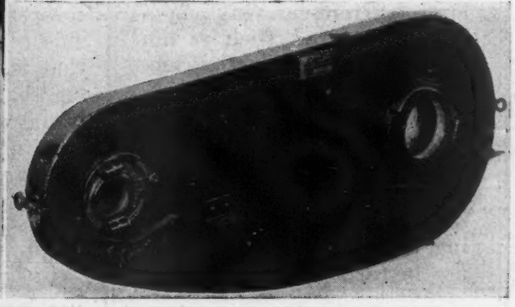


Fig. 1—This is a wave-wound, one-bar-per-slot winding used on the rotor of a large induction motor. Long and short bars are used alternately so as to secure two ranges for making the involute end connections. A close-up view of this winding is shown in Fig. 4.

Some of the Details About

Windings That Have One Bar Per Slot

Including the Manner of Making the End Connections and the Use of Long and Short Bars Together With Typical Winding Layouts

By A. C. ROE

Renewal Parts Engineering Department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WINDINGS having only one bar per slot are used principally in machines where large current-carrying capacity is required, such as the rotors of large induction motors and the stators of turbo-generators. This article, which is the second of a series of articles, discusses the uses of these windings in induction motors. A succeeding article will discuss their use in turbo-generators.

IN THE first article in this series on "Windings Having One Coil Per Slot," which appeared in the January, 1925, issue, it was pointed out that such windings are given that name because they have only one coil side in each slot. It was also developed that such a winding would of necessity be single-layer in the slot section, inasmuch as the slot can contain only one layer of coils. The coil ends, however, can be arranged in two or more layers. These windings are used principally on the older types of high-voltage motors and generators.

The previous article pointed out the various forms that one-coil-per-slot windings may take, such as the concentric chain, basket, diamond, and involute types of windings. The windings described, although having only one coil side per slot, had more than one conductor in each coil; that is, each coil consisted of more than one turn. We will now take up one-coil-per-slot windings in which a coil side consists of only one conductor; that is, a coil side would consist of one bar, and, therefore, each slot would contain only one bar. These windings are used principally in machines where heavy current-carrying capacity is required, such as the rotors of large induction motors and also in turbo-generators.

Windings having one bar per slot use long and short bars in the slot

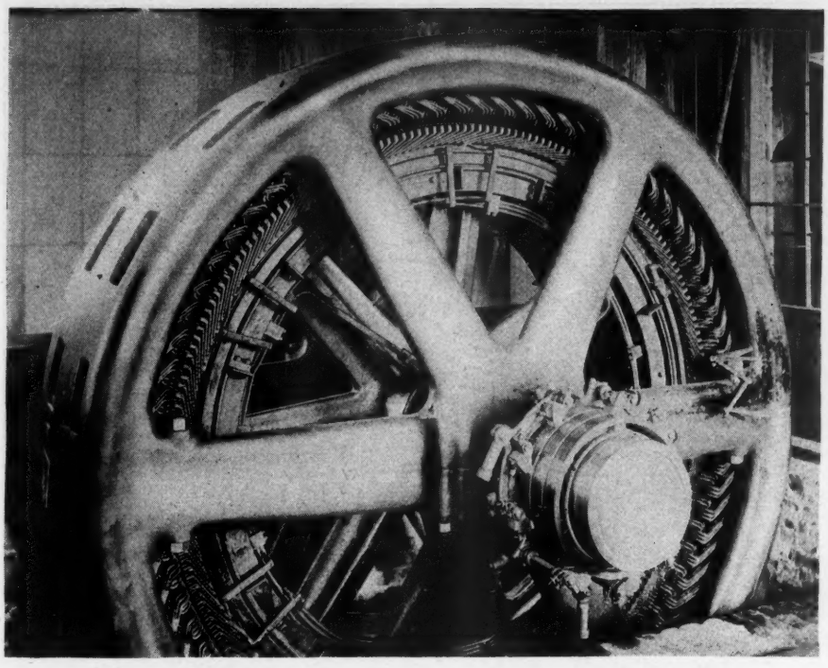


Fig. 2—Lap-wound, one-bar-per-slot windings are used on both the stator and rotor of this induction motor.

The end connections on both windings are of the involute type.

section and use the involute type of end connectors to form lap or wave windings, as required. Fig. 2 shows a machine having a one-bar-per-slot winding in both the stator and the rotor. In both cases, as can be seen by inspection of the illustration, involute-type end connections are used. Both the stator and the rotor of this machine are lap-wound.

In the preceding paragraph it was said that the bars in the slot section are of two lengths, a long bar and a short bar. This can be seen in Fig. 1. A close-up view of this same winding is shown in Fig. 4. Notice the use of the extra long bar for the connectors. Sometimes, instead of using the long and short bars, so as to obtain the space required for making the involute end connection, the bars are staggered, as shown in Fig. 3. In this case, the bars are of the same length, alternate bars being pushed to the right or to the left. Fig. 3 shows a wave winding.

A two-pole, two-phase motor having a one-bar-per-slot winding and using involute end connectors is shown in Fig. 10. In this winding the bars are all of the same length. The end connections are made in two ranges, being out on one side and in on the other. The winding diagram is shown in Fig. 11. It will be noticed that each phase is split into two concentric groups of coils. The winding diagram shows the complete connection for the A phase only. This winding has 120 slots, 60 slots per pole, and 30 slots per pole per phase, inasmuch as it is a two-pole, two-phase motor. The A phase is started at A_1, and connects to the front end of the bar in slot *1*. The winding then continues across the rear to slot *32*, across the front to the slot adjacent to slot *1*, that is, slot *120*, and so on through the coils of the concentric group. The concentric group ends in slot *46*. This group is connected to the second group by means of the jumper *XY*. The second concentric group starts at the front of slot *106*, then goes across the back to slot *47*, thence across the front to slot *105*, and so on through the group ending in slot *61*, which is the A_2 lead.

The starting lead for the B phase falls in slot *91*, and the finishing lead of the B phase falls in slot *31*.

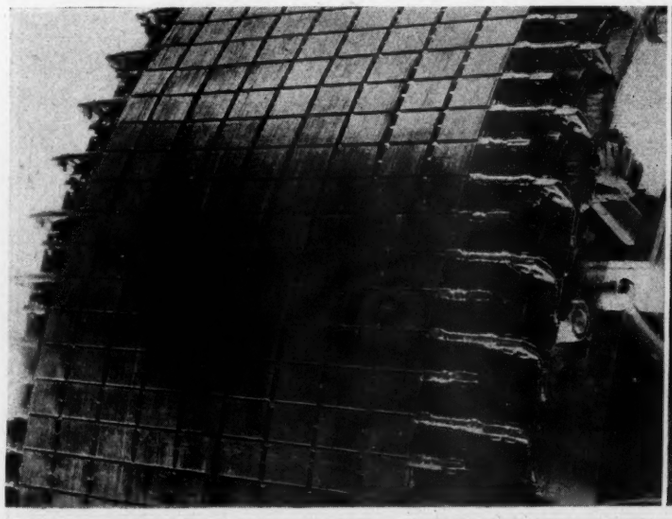
In four articles on "Laying Out Wave Windings" in the September, October, November and December, 1924, issues of INDUSTRIAL ENGINEER, a number of rules were developed for use in laying out wave windings. These rules also apply to wave-wound, one-bar-per-slot windings.

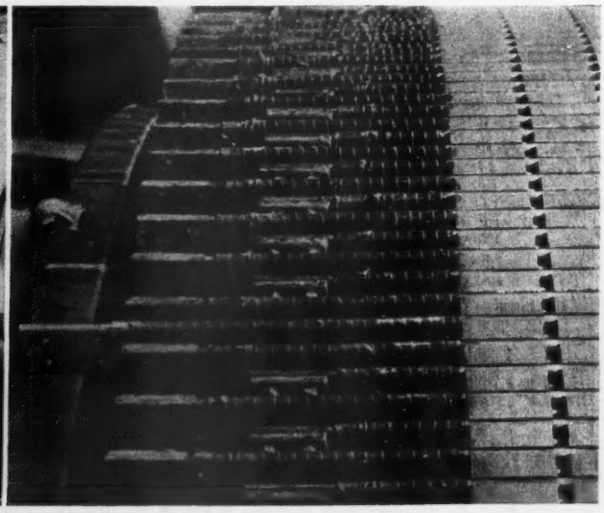
Let us consider a few layouts of windings having one bar per slot. In Fig. 5 is shown a three-phase, series-star winding having four poles and three sections instead of the usual six sections.

In accordance with the rules re-

Figs. 3 and 4—Two ways of obtaining two ranges on one-bar-per-slot windings.

In Fig. 3 the bars are of the same length. As can be seen, the bars are staggered so that in one slot the bar extends farther on the right-hand side and in the next slot the bar extends farther to the left. This machine is wave-wound. In Fig. 4 two ranges are secured by using long and short bars alternately. Fig. 4 is a close-up view of the winding shown in Fig. 1.





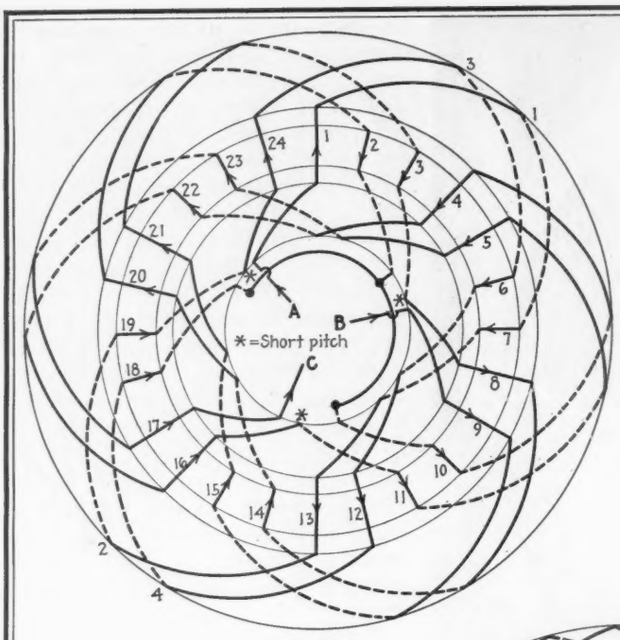


FIG. 5

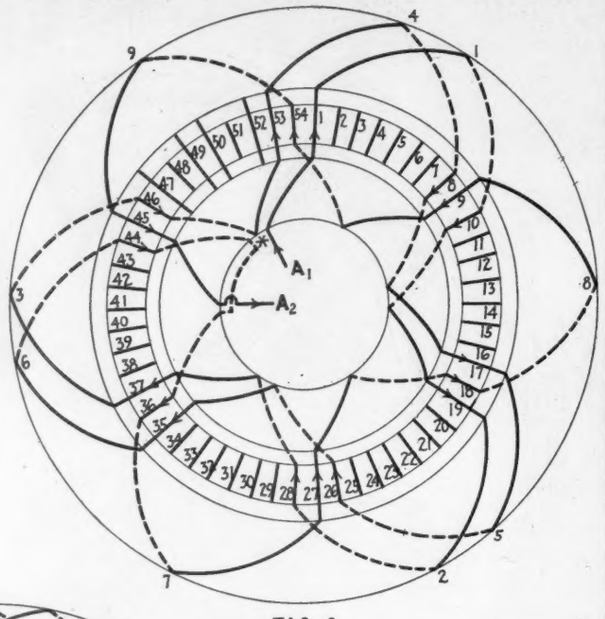


FIG. 6

Figs. 5 to 9—Here are typical wave-winding layouts for one-bar-per-slot windings.

In Fig. 5 is shown a three-phase winding having four poles, 24 slots, and three sections. Each section has four coils. This type of winding groups the end connections and has a minimum number of leads, inasmuch as no reversing jumpers are required. Fig. 6 shows the first phase of a three-phase, six-pole winding, having 54 slots and 27 coils. Each phase has two sections, the first section having six coils and the second section three coils. The complete diagram with the phases connected series-star is shown in Fig. 7. Fig. 8 shows the same winding arranged in three sections, or one section per phase, each section having nine coils. The start and finish of the phases are shown and also it can be seen that the phases start with long bars and finish on short bars. It will be noticed that the bars are grouped in sets of three, that is, three long bars are followed by three short bars and so on. This layout has fewer connections than the one shown in Fig. 7 as it eliminates the reversing jumpers. In Fig. 9 is shown the layout for a two-phase winding having 12 poles, 48 slots, and 24 coils. The bars are grouped in sets of four, each set being staggered somewhat in the manner shown in Fig. 3. There is only one section in each phase; consequently each section contains two series of six coils each.

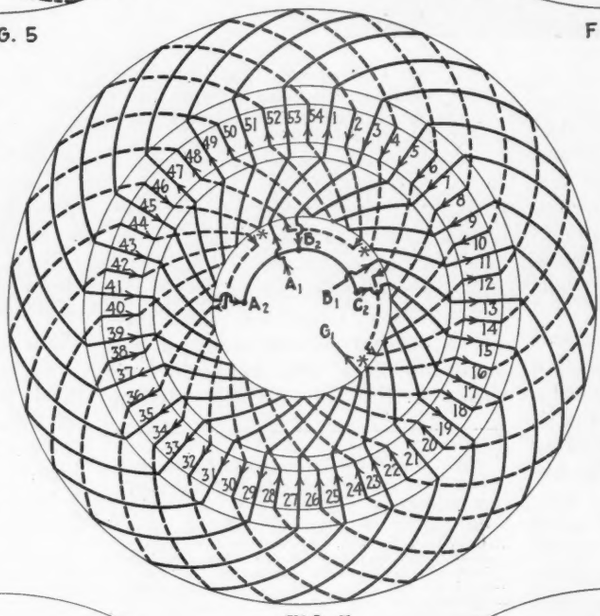


FIG. 7

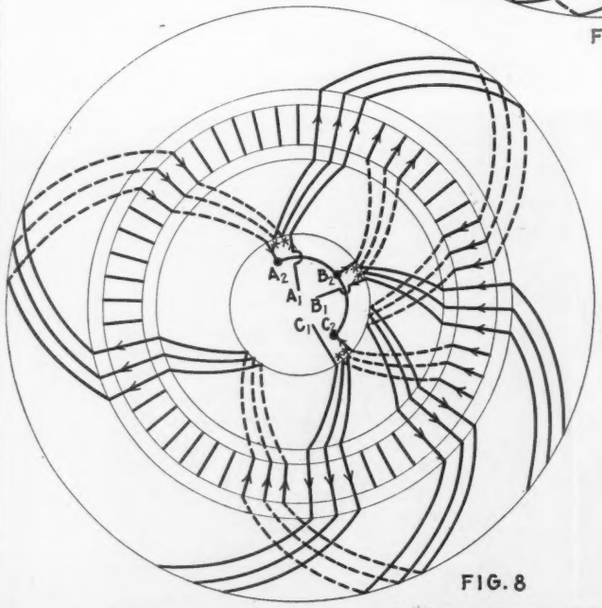


FIG. 8

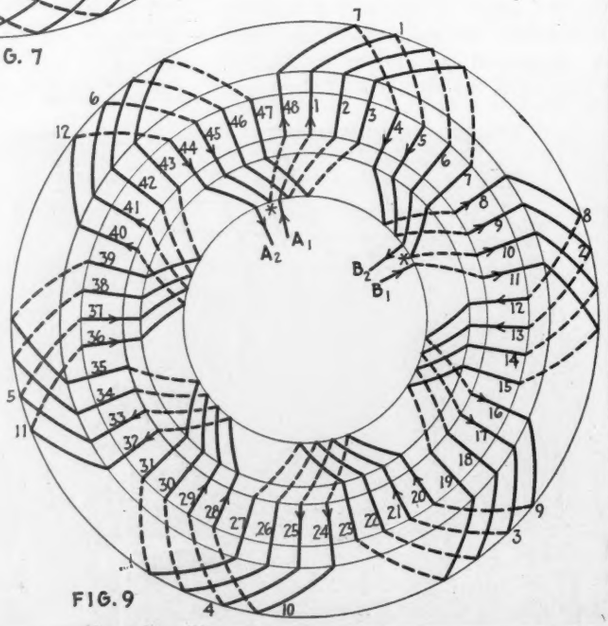


FIG. 9

ferred to in the preceding paragraph the phases are started in slots *1*, *9* and *17*. Let us start the A phase in slot *1*.

The bar in slot *1* is connected across the back to the bar in slot *7*, and this bar is connected across the front to the bar in slot *13*, which in turn is connected across the back to the bar in slot *19*. The front end of the bar in slot *19* is connected to the front end of a bar in a slot which is a distance equal to a short pitch away, that is, in slot *24*. The winding then continues through the second series of coils in this section; it continues through slots *24*, *6*, *12* and *18*. The front end of the bar in slot *18* is connected to the star point.

It will be noticed that two lengths of bars are used in this winding. The winding starts on a long bar, then goes through a short bar, and continues alternately through a long bar and a short bar. This is done so as to provide two ranges in which the involute end connections may be made. The involute connectors overlap each other so that the top half of the connector is connected to the long bar and the bottom half of the connector is connected to the end of the short bar.

The overlapping of the involute end connectors can be seen in Fig. 3. In the diagram the top halves of the connectors are shown in full lines and the bottom half of the connectors is shown in dotted lines.

This style of winding groups the end connectors and has a minimum number of leads.

A three-phase, one-bar-per-slot, wave winding having six poles, 54 slots and 27 coils is shown in Fig. 6. Since there are 27 coils and three phases, there will be nine coils per phase. In this winding, there are two sections per phase; hence six coils are put in one section and three coils in the other. In Fig. 7 the first section is shown complete. As can be seen, the phase starts in slot *1* and continues through the first series of coils to slot *46*, where it is connected by a short pitch to the second series of coils starting in slot *53*. It continues through this series of three coils to slot *44*. This is the end of the first section of this phase. By means of a reversing jumper the front end of the bar in slot *44* is connected to the start of the second section; that is, the front end of the bar in slot *36*. The winding continues through the second section of three coils and ends in the bar in slot *45*, the front end of which is connected to the star point.

Long and short bars are used alternately in this winding in order to secure two ranges for making the end connections between bars.

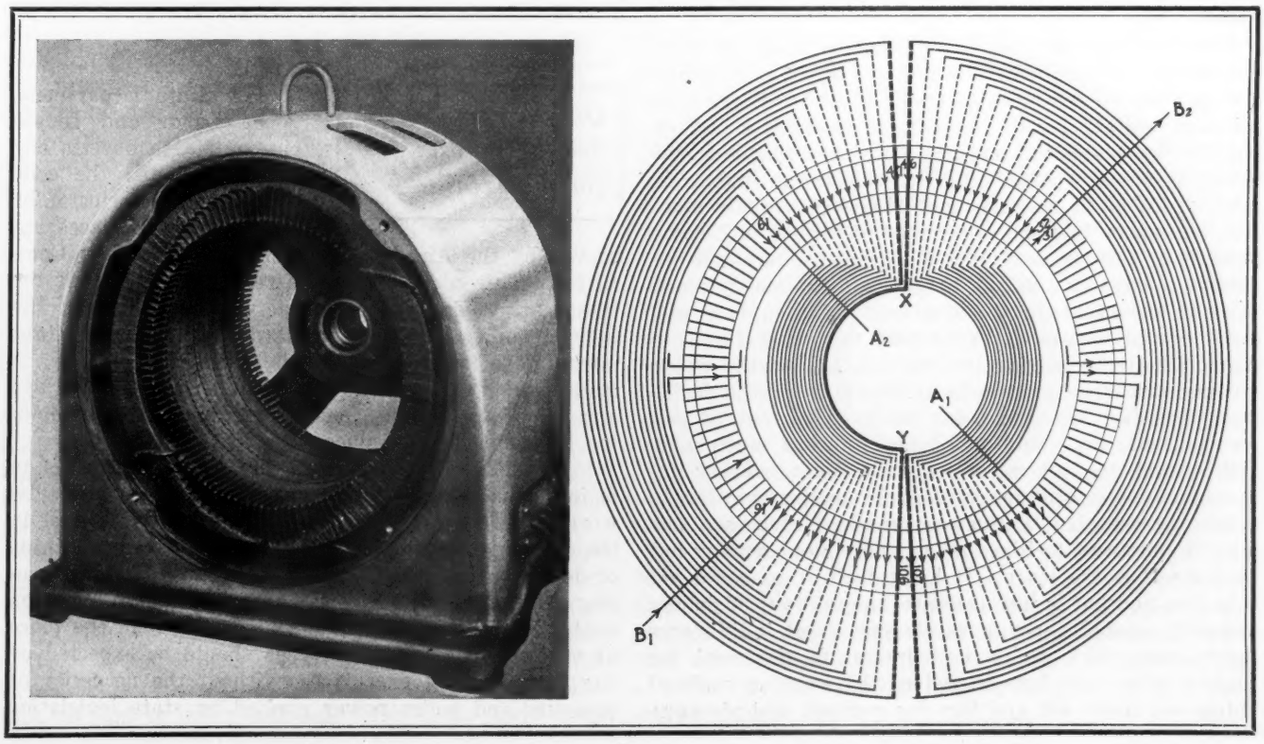
Fig. 7 shows the completed diagram for this winding. In connecting the phases a series-star connection has been used.

In Fig. 8, this same winding has been arranged with three sections instead of six, each section of which has nine coils. In this diagram the start and finish of the phases are shown, also it can be seen that the phases start with long bars and finish on short bars. Also it will be noticed that the bars are grouped in sets of three; that is, three long bars are followed by three short bars and so on. With this arrangement of this winding, no reversing jumpers are required.

A two-phase winding, using bars all of the same length, is shown in Fig. 9. This winding has 12 poles, 48 slots and 24 coils. It is wound in two sections. The bars are grouped in sets of four, each set being staggered somewhat in the manner that the bars are staggered in the machine shown in Fig. 3. As has been said, there are only two sections in this winding; that is, each phase is complete in one section. Each section of coils has two series, each series contains six coils.

In a succeeding issue the final article of this series on, "Windings Having One Coil Per Slot," will be given. The final article will treat of one-bar-per-slot windings as used in turbo-generators.

Figs. 10 and 11—This is a lap-wound stator using bar conductors arranged in four concentric groups. This machine is rated at 125 kva., 480 volts, 3,600 r.p.m., 60 cycle, two-phase and is made by the Burke Electric Co., of Erie, Pa. It has 120 slots, each of which contains only one bar. There are 60 slots per pole and 30 slots per pole per phase. In the wiring diagram shown in Fig. 11 is given the connection scheme of the winding.



INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories

DANIEL H. BRAYMER
Editorial Director

Assisted by

G. A. VAN BRUNT F. E. GOODING A. J. WHITCOMB

Chicago, March, 1925

Who Pays for the Things You Waste?

AN ITEM in a recent issue of the *Studebaker Employees' Magazine* carries a thought on preventable plant leaks and wastes that we want to pass on to our readers. It read as follows:

Whether you waste water, oil, gas, air, or electricity by failing to shut off these supplies promptly when their use is unnecessary; whether you waste a pin, or a bar of steel, or an hour's time—you pay for it. Everything which Studebaker buys is charged into the prices of Studebaker cars. All costs, and therefore all losses and waste, must be absorbed in the selling prices of the cars.

Studebaker must continue to build a better car at a lower cost than other manufacturers if it is to compete successfully in the automobile business, **employ men** and **pay wages.** And, of course, the more Studebaker cars that are sold, the more continuous will be the employment of Studebaker men. Further, a concern which has less waste and loss to consider in its costs, **can afford to pay better wages.**

There is nothing new in these statements of fact. The wastes in the production and upkeep of every plant are included in the price of the product. But the idea inferred and expressed, that the employees of a factory pay for the wastes they create, in the long run, is worth thinking about. After all, the consuming public is made up of all of us, and most of us are workers making, selling, or in some other way identified with some product or service associated with that product, and we receive a wage or a salary based upon the money made through the efforts of all concerned. If, then, each and every one of us would realize that through failures to participate in the savings we could make, because we do not make them, a waste of our own time or the facilities furnished for doing our work comes out of our own pockets, we would watch these things more carefully. And, too, whenever we see a fellow worker unnecessarily wasteful or careless in such a way as to create preventable wastes, we would clearly see our duty to point out to him that not only our company but he himself is the loser. If he and all of us could get this idea and put it into practice, the millions of dollars annually wasted through carelessness and indifference would come back to us by eliminating the need for higher prices and help to reduce the existing costs of things we wear, eat and buy for comfort and pleasure.

In the final analysis, it is true that all of us pay for the wastes that we collectively create. Think this over and tell your men about it. It's a good thing to start an argument over at least, for it's an economic problem close to the heart and pocketbook of all of us who work for a living and want the highest return for our services.

The Repair Shop Is Not a Renewal-Parts Factory

THAT the majority of brush troubles are due to poor pigtail connections, was the opinion expressed by the field engineer of a large brush manufacturer. Brush troubles manifest themselves in many different ways and the usual conclusion is that something other than loose pigtails is causing the trouble.

One reason for pigtail trouble can be traced to the surprising amount of home-made brushes that are in use. Most reputable brush manufacturers have methods of making pigtail connections in such manner that they will not come loose. The average small repair shop does not.

Large users of carbon brushes state that there is no one grade of brush that can be universally applied to all of the plant equipment. For each type of equipment, there is a grade that will give maximum life with satisfactory performance. The average small repair shop is not in a position to experiment with the different grades of carbon to determine which will give the best results. In a plant where several grades of brushes are required, the plant repair shop cannot buy carbon in quantities or quality that will result in lasting economy so that for this reason alone the plant repair shop is not the place to start a brush factory. Although the price of carbon slabs is much less than the cost of finished brushes as supplied by reputable brush manufacturers, the cost of brushes should be measured in years of satisfactory life rather than in the first cost per brush.

In the last analysis, a repair shop is a place to repair broken equipment, and not to manufacture repair parts.

Only a Few Can See the Forest for the Trees

THE State Department of Labor and Industries of Massachusetts has recently adopted the code for lighting factories, mills and other work places approved by the American Engineering Standards Committee. This code follows the recommendations of the Illuminating Engineering Society and deals with the lighting of exits, and standards of minimum light intensity for workrooms, yards and storage spaces, to make working in these places safe and to reduce eye strain on close work. General requirements for shading light sources to reduce glare are also included.

It should not be necessary for state authorities to police common-sense lighting requirements in industrial works, for good lighting is just as effective a tool in the economical production of a product as any machine or device that is bought and used because it can be employed at a profit. The same application of common sense that causes efficient machinery to take the place of obsolete and inefficient types should be expected on the part of plant executives, without the necessity of pressure and police power applied by state legislation

or inspections. Some time this fact will be realized, but as yet the credit for the economies in production quality and quantity resulting from lighting adequate for different working conditions cannot be claimed as an accomplishment of plant management or operation. It is and will continue to be a horrible example of not being able to see the forest for the trees, unless plant operators wake up and raise their lighting installations to the same standard of operation that they insist upon for other production methods, machines and tools.

Industrial Demands for Power

ADVANCE sheets of the first 175 pages of a report soon to be issued by the Giant Power Survey Board of the State of Pennsylvania give some very illuminating facts on production and utilization of power, which in that state exceeds 13 billion kilowatt-hours per year. That is more than is required by any two other states of this country.

It is pointed out in this report that 75 per cent of every dollar of wealth produced in Pennsylvania is from manufacturing and that it has twice the volume of installed horsepower in industry of any other state. In 1904 the energy used was 4,200 kw.-hr. per worker. Today it is more than 8,500 kw.-hr. per worker, an increase of more than 100 per cent, with a 41 per cent increase in the number of workers during the past 20 years. If the use of power continues at the present rate, the Board predicts that by 1950 the industries of Pennsylvania will require double the installed horsepower that exists today, or more than 13,000,000 hp.

These figures are a good index to the growth of manufacturing in this country and the extent to which electrical drives and other equipment that depends upon electrical energy for its operation are being installed. Motor applications and the mechanical devices that are employed in this connection offer a wider field for specialized attention than ever before, because the range of drives is greater and the variety of operating requirements is continually increasing as industrial processes are improved and changed to bring about greater production economies.

If Horace Greeley were alive his advice most probably would be, "Young man specialize in electrical and mechanical drive engineering."

How Safety Helps Machinery As Well As Men

ORIGINALLY industrial safety devices were installed to reduce the appalling number of serious injuries, maimings and deaths which were considered by some as inseparably linked with production. The result was more than expected. Savings of life and of limb and of cost of compensation have exceeded the cost of protection. Safety work has paid for itself.

There is still another class of industrial safety work which also pays for itself. This deals with the protection of machinery, motors and other production equipment. Incidentally both types of safety work are closely related. A guard on a chain drive, for example, which keeps fingers or hands out also prevents wrenches, bolts, nuts, oil cans or practically any other metal parts from getting in and damaging the chains or teeth in the sprockets. Similarly, where oil or grease cups are located in points difficult or dangerous of access, the oiler can hardly be blamed for "overlooking" them occasionally. Grease cups or pipes extending out through a guard leave no excuse for neglect—also no likelihood of injury. Here the protection to the man is incidentally good protection to the machine because neglect in lubrication is one of the common causes of mechanical breakdowns.

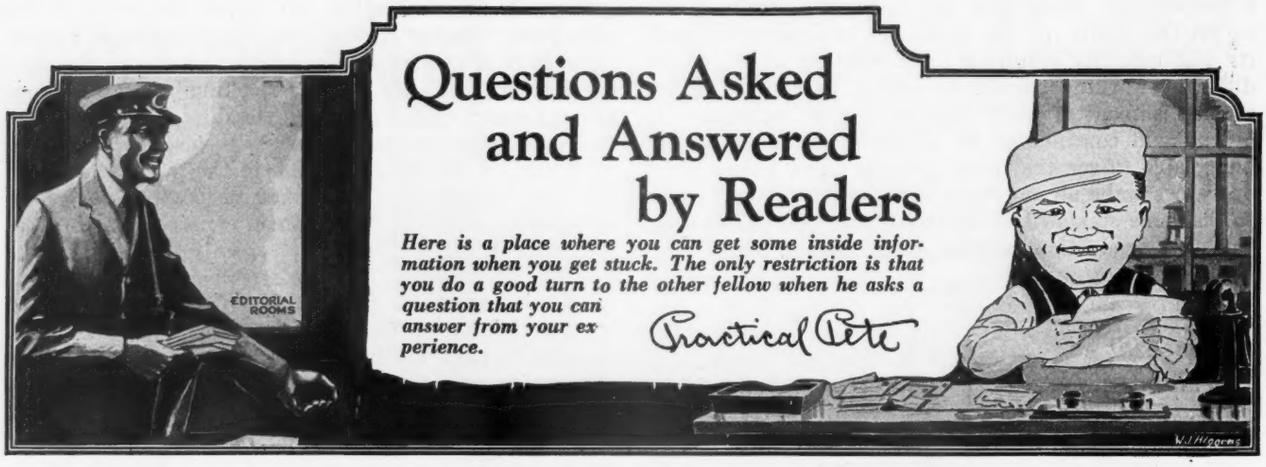
Other advantages from the standpoint of mechanical safety as applied at the Battle Creek, Mich., plant of the Postum Cereal Co., are taken up in the article beginning on page 118 in this issue. Here the plant is in continuous operation and breakdowns or interruptions would be serious. When a machine fails and goes to the repair shop "hospital," production stops and in some departments the product is a total loss. For this reason every precaution possible is taken to see that no breakdowns occur and that injuries to workmen are avoided.

Overfeeding and Starving Storage Batteries

MOST of us who drive automobiles have an opportunity to learn a lot about storage batteries that will be useful in obtaining the maximum service from them when used in plant work. One thing that cuts down the useful life of battery plates in any service is regular overcharging or charging at too high a rate. Excessive overcharging will tend to buckle the plates in the same way as violent discharging, and will be indicated by the battery plates and connections heating up. Excessive heat causes unequal expansion of the active material and will bend the grids out of shape and start trouble that can only be remedied by extensive repairs through replacement of the damaged plates. Excessive heat also hastens the chemical decomposition of separators which results in short-circuits.

In the majority of cases when short life of batteries is experienced in electric industrial trucks the trouble can be traced to careless handling of the battery charging and to abuse while in operation through allowing the batteries to stand in a discharged condition or failure to keep the plates covered with water, producing a condition of sulphation that requires expert treatment when the battery is placed on charge. Plates that are partially sulphated can be saved in many cases by simply charging at a low rate for three or four days and not allowing the temperature of the battery to exceed 100 deg. F. But if such a battery is placed on charge at a high rate, the plates will get hot because only those parts not covered by lead sulphate carry the current, and besides the cells will begin to gas excessively and cause shedding of the active material. The battery will then be quickly ruined.

The lead storage battery as now constructed is about the sturdiest piece of electrical apparatus made, when given a chance to work under favorable conditions. When unusual trouble is experienced and batteries wear out quickly the causes can usually be found and removed by regular inspections by an experienced battery man and a little more care and attention when they are charged. Charging a battery is like feeding a horse—if you overfeed him he founders and if you starve him he dies.


EDITORIAL ROOMS
Questions Asked and Answered by Readers
Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.
Practical Pete
W. J. Higgins

Who Can Answer These?

Thickness of Mica Required for Slot Insulation—Will some reader please tell me what thickness of mica should be used to replace one layer of 0.007- or 0.010-in. varnished cambric and one layer of 0.007- or 0.010-in. fishpaper for slot insulation?
St. Louis, Mo. L. C. R.

* * * *

Trouble With Rewound Automobile Generators—I have been rewinding some automobile generators, but in spite of the fact that I always check up the old winding and make the new one as nearly like it as possible I sometimes have trouble in getting the proper amperage out of the generator. The voltage will be up to normal, six volts, but the charging rate is too low. I wish some reader who has had experience in such work would give me some suggestions as to where the trouble may be.
Bathurst, N. B., Can. H. J. M.

* * * *

Connecting Three-Phase Power Factor Meter—I should like to obtain the following information from some of the readers of INDUSTRIAL ENGINEER. (1) How may a three-phase power factor meter of General Electric make, be connected up for correct operation on either leading or lagging current when all of the polarity marks have been obliterated? (2) How may the circuits of the above meter be tested for continuity and zero setting of the pointer when it has been moved on the revolving shaft which supports it? (3) What would cause a shunt generator driven by an induction motor to build up slowly at the commutator and develop destructive arcing at the brushes after the load has been removed? What would be the remedy for such a condition? The armature is a single, parallel winding.
Saskatoon, Sask., Can. F. N. G.

* * * *

Arrangement of Motor Testing Panel—We have recently fitted out an electrical repair shop in our mill and have all of the necessary equipment except a testing panel for motors. Voltages of 110, 220, 440 and 2,200, three-phase, are available and I have a blank panel measuring 2 ft. by 3 ft. which I should like to use, if possible. I shall appreciate it if some reader will tell me how to lay this out in the most convenient fashion for testing a.c. and d.c. motors before and after rewinding, including high-voltage tests between coils and between coils and ground, and running tests.
Cloquet, Minn. E. S. B.

* * * *

Using Vacuum Pump as Air Compressor—I have a Wahl vacuum pump, size 4 in. by 2½ in., with ¾-in. inlet and outlet, which I wish to use as an air compressor. The pressure in the air tank need not go over 125 lb. per sq. in. Will someone please tell me, (1) What size motor would be required to drive this pump at 275 r. p. m. (2) Will it be necessary to make provision for cooling this pump artificially, by means of air fins or water, in order to keep the temperature down to a safe limit? (3) How do you figure the cubic inches of air compressed per stroke?
Dallas, Tex. R. E. L.

* * * *

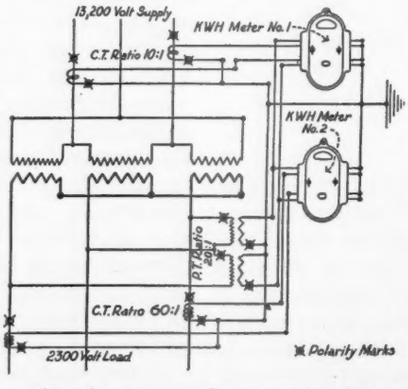
How Long Will It Take to Erect These Towers?—I shall appreciate it very much if some of the readers of INDUSTRIAL ENGINEER can give me the amount of time in man-hours required to erect five steel transmission towers, 9 ft. by 15 ft. at the base and 60 ft. high. I should also like to know the time required to string three No. 3/0 stranded copper cables and one overhead ground wire a distance of 2,000 ft.
Appleton, Wis. M. P.

* * * *

How to Use Megger for Testing Insulation of Motors—I wish some reader would give me a few suggestions on the proper method of using a megger for testing the insulation resistance of motors. I should also like to know what is considered a satisfactory reading when testing 110/550 volt, a. c. and d. c. motors ranging from 5 hp. to 50 hp.
Latrobe, Pa. J. K. W.

* * * *

Will These Watt-hour Meters Read Alike?—The diagram shows a proposed method of connecting watt-hour meters on the primary and secondary sides of a bank of transformers connected delta-star. As shown, the meter measuring the high-tension power receives its current from current transformers in the lines supplying the delta-connected primary, while the potential supplied is the low-tension line voltage. The low-tension watt-hour meter is connected in the usual manner. I should like to know if this connection for No. 1 meter will work satisfactorily. Also, if we disregard the copper and iron losses in the transformers will there be any difference in the records of the two meters at unity power factor, and at 85 per cent, 70 per cent and 45 per cent lagging power factor, assuming that the load is always balanced?
Longview, Wash. J. C. R. C.



Answers Received To Questions Asked

Commutator Trouble with Interpole Motor—I have a 15-kw., six-pole, compound-wound, interpole exciter, for a synchronous motor, that has three black and somewhat flat spots at equal intervals around the commutator. This machine has a lap winding and the mica is not undercut. There is always some sparking at the brushes. If I shift the brushes, the black spots move in the direction the brushes are shifted. I lifted the leads from their risers at each spot and tested for open circuits with a test lamp, but everything seemed to be O. K. Will some reader please suggest a cause and the remedy for this trouble?
St. Croix Falls, Wis. K. A.

In reply to the question by K. A. in the November issue, I would suggest that he carefully test the armature for high-resistance connections or open circuits, as the symptoms he describes point to this form of trouble. It might also be that there is a high-resistance brush contact at the particular bars that seem to blacken. It would thus be well for him to see that the brushes make good contact with the bars. Probably it would be advisable to undercut the mica very slightly. I would suggest, as a further precaution, that he check up the clearance between the armature and pole faces, to see that the clearance is equal at all poles.
Muncie, Ind. GEORGE CROPPER.

* * * *

Referring to the question by K. A. in the November issue, I would say that, if these blackened "flats" occurred after the generator had been operating successfully for some time, the symptoms described would indicate trouble in the equalizer connection. Apparently K. A. has made sure the trouble is not due to defective soldering of the armature leads to the commutator bars. His next move should be to examine carefully the taps from the armature winding to the equalizer rings. I take it for granted that this exciter is equalized with cross-connectors, as this is standard practice with lap-wound, multi-polar machines such as he describes. If such is the case, and the machine has behaved this way since it was first put in operation, the trouble is probably due to the use of too few equalizers. These equalizing rings are mounted either at the commutator end or at the rear end of the armature; in one case they are tapped to the risers of the commutator bars, and in the

other case to the armature conductors themselves. There should be as many equalizers as there can be made room for; at least, one for each armature slot. These equalizers connect together all points in the armature winding which are at the same potential, thus preventing a heavy flow of current through the various armature paths. When there are not enough equalizers, or when their resistance is increased by defective joints, the heavy currents flowing internally produce just about the same effect as K. A. describes.

Honesdale, Pa. J. M. WALSH.

* * * *

In the November issue of INDUSTRIAL ENGINEER, K. A. reports three black spots on his exciter commutator and has tested for open circuits and found none. Black spots as described are caused by short-circuited coils as well as by open-circuited coils. Possibly this is the trouble in the present case.

ROGER F. EMERSON.
Industrial Engineering Dept.,
General Electric Co.,
Schenectady, N. Y.

* * * *

In answer to K. A's. question in the November issue, I believe the poor commutation on his 15-kw. six-pole exciter is due to one of several faults, or a combination of them.

He states that the commutator is not undercut; therefore, the first cause may be high mica. A flat is often started by one high mica segment lifting the brushes from the commutator bars under one brush arm, thereby overloading the other two brush arms of like polarity and burning the commutator segments at these points also. In this way, three flats are started 120 deg. apart and the blackened areas gradually grow wider.

The remedy for this is to turn the commutator in a lathe, taking pains to see the flats are removed and then undercut the mica about $\frac{1}{32}$ in.

Another cause would be one or more high-resistance connections at the risers. A high-resistance contact can be located by testing the armature from bar to bar by the drop-of-potential method. When located, resoldering will correct this trouble.

Again, the brushes may not be properly spaced and may not be set on the neutral point. To correct the spacing, count the bars between brushes and shift individual brush arms until there are the same number of commutator bars between the brushes, counting from toe to toe of all brushes.

To check the neutral, the kick method is very accurate, if properly used. It should be carried out as follows: Lift all brushes from the commutator and insert two brushes (one in a positive and one in a negative brush arm). These brushes should be sanded down so as to bridge only one mica segment in the center of the brush holder. Now separately excite the shunt field with approximately 50 per cent of the exciter's rated voltage, with a test switch between the exciter and the source. Connect a low-reading d. c. voltmeter, say 0 to 2 volts, across the two special brushes and close the test switch; then slowly open it again while watching the voltmeter. If a deflection of the voltmeter pointer is noticed, the brushes should be shifted until the least deflection is obtained. The brushes are then set on neutral, which should be correct for a machine with interpoles.

Another condition which would tend to cause poor commutation is worn bearings. This would allow the armature to vibrate, causing sparking at the brushes. New bearings would correct this.

The armature may be out of balance. This will also cause sparking and wear in the bearings. Re-balance the armature in this case.

K. A's. trouble may be due to one or more of the foregoing conditions, and I hope this information will be of some benefit to him.

Columbus, Ohio. G. B. H.

* * * *

Referring to K. A.'s question in the November issue, about a year ago I had a similar experience with a 100-kw., 1200-r.p.m., 6-pole, compound-wound, interpole, motor-driven generator used for exciting purposes in one of our generating plants. Carbon brushes somewhat abrasive in character had been used on the commutator of this exciter, with the result that it was badly worn in ridges. In an endeavor to smooth down the commutator, a commutator stone was used, but because of unskilled handling a flat spot was made and the commutator was ground slightly out of round, or eccentric.

When placed in service considerable sparking was immediately noticed and when shut down after a short run, three black spots were in evidence at three equidistant points on the commutator. One of the black spots was on the flat spot previously noted. As the machine was urgently needed it was run in this condition for some time, but as the sparking gradually grew worse, the armature was finally removed and the commutator turned down with lathe tools.

A suitable non-abrasive brush had meanwhile been recommended for this unit by a reliable brush manufacturer and when a set of these were mounted after turning down the commutator, the results were excellent. The unit has now been operating for over a year without the slightest sign of sparking and with that healthy commutator color that indicates good condition of brushes and commutator. FREDERICK KRUG.

San Juan, Porto Rico.

* * * *

Referring to K. A.'s question in the November issue, I would suggest that you tap the bars lightly all around the commutator and note whether they move or have a tendency to vibrate when struck. If the commutator shows any signs of being loose, take the armature out, heat the commutator thoroughly with a blow torch and try to tighten the retaining nut at the end. After the commutator has cooled off tap it again with hammer and see if it is now tight. If it is not, take off the retaining nut, remove the front V-ring and put on 0.010 in. or 0.020 in. of molding mica. Now put the V-ring back in the commutator and tighten it as much as you can with the retaining nut. Then heat the commutator again as above and try to tighten it while it is hot, and again after it has cooled off. Then if it sounds solid, put it in a lathe and turn it down smooth.

I would also advise you to undercut this commutator about 1/32 in., not more, for if it is undercut too deeply carbon and copper dust will accumulate between the bars and sooner or later cause a short-circuit.

It is also possible that the brush holders are now set at a different angle or in a different position than they were originally. To check up the neutral point connect a millivoltmeter, or a low-reading voltmeter, across any two adjacent brush holders with the armature circuit open and pass direct current through the field. It is advisable to place the d. c. switch close to the motor so that you can open or close the switch quickly. As you make and break the circuit through the field there will be a deflection on the meter. Now, moving the brushes back and forth you will find a point where there is no deflection; this is the neutral point, on which the brushes should be set.

It is also possible that equalizers should be put in this armature, as these will prevent circulating current caused by unequal air gaps, worn bearings, or by one field pole being weaker than another. If you decide to put in equalizers you will probably find sufficient room back of the commutator, on an armature of this size. Take a small chisel and cut slots in all of the risers on which you want to put equalizer connections. The wire used for the equalizers should be not less than one-half the circ. mil area of the wire in the armature. On page 599 of the December, 1924, issue of INDUSTRIAL ENGINEER, A. C. Roe explained in detail how to calculate the number and position of the equalizer connections.

NICHOLAS J. WEISS.

West New York, N. J.

* * * *

Motor-Generator Set for Testing Small Single-Phase and Three-Phase Motors—Will some reader please tell me what capacity motor-generator set (d.c. motor—a.c. generator), method of drive and style of generator I could use for testing single-phase and three-phase, 60-cycle, 220-volt motors up to 1 hp. rating? Is it possible to change over from 25 cycles to 60 cycles, from 110 to 220 volts and from single phase to three phase, or the reverse, just by means of throwover switches? What changes would have to be made in the motor and generator in order to secure 25-cycle current? What capacity would be obtained from a 60-cycle set delivering 25-cycle current?

Chicago, Ill. E. J.

Referring to the question by E. J. in the November issue, the simplest kind of set to operate, if all testing is done at 60 cycles, 220 volts, would be one having a single-phase rating, for the a. c. generator, of 1 hp. per phase or 3 hp. on three-phase. This would have a rating of about 2.25 kva. at 100 per cent power factor, as a three-phase machine, and would be of sufficient capacity unless testing is carried on continuously, in which case a machine of 3 kva. would have ample capacity.

To test 25- and 60-cycle motors, it would be best to have either two separate motor-generator sets, one for each frequency, or one motor driving two generators. If it is desired to test a 25-cycle motor on a 60-cycle generator it would be necessary to reduce the generator speed to 25/60 of the 60-cycle speed and increase the field excitation to keep up the voltage. This could probably not be done with a commercial generator. On the other hand, if the generator operates normally at 25 cycles, the speed would

have to be increased to 60/25 of the 25-cycle speed and the excitation decreased to give the correct voltage. It would probably not be possible to obtain a commercial machine which would operate through this speed range.

Generators can be purchased with a single stator and two separate revolving fields, one for 25 cycles and one for 60 cycles. Machines of this type are in use in laboratories where the delay involved in changing the fields is not of serious moment.

It should be remembered that only certain speed-and-pole combinations can be used in sets for a combination of 25- and 60-cycle operation. The most usual combination is a speed of 300 r. p. m., which would require a ten-pole machine for the 25-cycle unit, and a twenty-four-pole machine for the 60-cycle unit. With machines of such low capacity it would probably not be possible to obtain these combinations and it would therefore seem best to purchase separate sets having commercial speeds, rather than to combine all of these features in one machine or set.

A change of voltage from 110 to 220 volts can readily be made with a throwover switch, but from the foregoing it may be noted that a change in frequency is not so easily obtained.

A 60-cycle machine operated at 25 cycles would, providing the voltage is kept up by an increase of field excitation, have the same capacity. But the field would have to be especially designed for such service. For a commercial machine it would be necessary to limit the field current to a definite maximum. This would, of course, give a lower voltage at the reduced speed and reduced capacity in proportion to the reduced voltage, the exact value being dependent upon the design of the machine. In addition, it would probably be necessary to provide transformers to raise the voltage to 220 volts if required.

Summing up the whole matter, I believe it would be best to purchase separate sets to operate at commercial speeds and not attempt to obtain a very special outfit which would of necessity be higher in cost.

C. OTTO VON DANNENBERG.
The J. G. White Engineering Corp.,
New York, N. Y.

* * * *

Referring to the question by E. J. in the November issue, the simplest outfit, and no doubt the cheapest, would be a motor-generator set driven by a variable-speed d. c. motor. This set should be 5-kva. capacity, or thereabouts.

The generator should be direct connected to a d. c. motor of suitable voltage. The speed of the motor should be 1,200 r. p. m. or 1,800 r. p. m. at full speed; 1,200 r. p. m. will give 60-cycle current with a six-pole generator and 1,800 r. p. m. will give 60-cycle with a four-pole generator. The generator should be of the stationary-field type, rated at 220 volts, 60 cycle, three phase. Now, 110 volts can be obtained by weakening the field of the generator through a properly designed rheostat. Single-phase current can be obtained from any two leads from the generator.

For 25 cycles the generator speed will have to be reduced to 500 or 750 r. p. m., depending on whether it is a four-pole or six-pole machine. Through the use of a suitable speed regulating rheostat on the drive motor, this speed can be obtained. By regulating the field strength of the generator, either 110 or 220 volts, single phase or three phase, can be obtained at 25 or 60 cycles.

I would advise the use of a 5-kva. generator direct connected to a 5-hp. d. c. motor so that the outfit will have sufficient capacity at 25 cycles, as the capacity at 60 cycles will be 240 per cent greater than at 25 cycles. The only switches necessary will be a three-pole switch for the three-phase current. A two-pole switch for the single-phase current would be convenient if E. J. desires to test a single-phase and a three-phase motor at the same time.

Donnacona, Que., Can. LEE F. DANN.

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Design of a Growler for Testing Armatures—I wish some of the readers of INDUSTRIAL ENGINEER would tell me how many turns and what size wire to put on a laminated core in order to make a growler for testing armatures up to 50 hp. in size. This core is 8½ in. x 4 in. x 4 in., and has a 1¼-in. slot cut into it. If necessary I could make the core longer. Alternating current of 110 or 220 volts is available for operating the growler.

Canton, Ohio. R. M.

In answer to the inquiry of R. M. in a recent issue for information on the construction of a growler, I wish to submit the accompanying diagram and information: The smaller growler will take small electric drill or fan motor armatures from 1¾ in. in diameter up to about 4 in. in diameter. As will be seen from the drawing, it is built up of laminations stacked to a thickness of 3¼ in. and riveted to 4 pieces of angle iron by means of which the laminated core is attached to the wood base. For use on 110-volt alternating current the coil is wound with 150 turns of No. 13 B. & S. gauge d. c. c. wire. The push switch shown at the right serves for turning the current on or off.

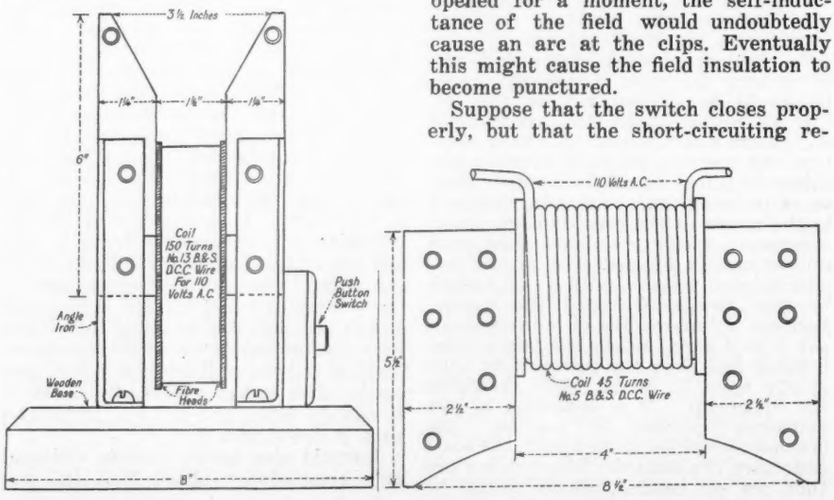
The larger growler is 5½ in. high, 8 in. thick and has a radius of about 9 in. For 110 volts the coil is wound with 45 turns of No. 5 B. & S. gauge d. c. c. wire. This growler has given satisfactory results on armatures up to 30 in. in diameter.

These two growlers cover a wide range of armature diameters and will usually be found sufficient for most requirements. Care should be taken not to apply the current until the armature to be tested is in place on the growler and not to remove the armature before the current is turned off, so as to prevent an increase of current through the growler winding, which might cause it to burn out.

To wind these growlers for use on 220-volt alternating current, double the number of turns and use wire of half the size employed when the growlers are used on 110 volts.

Cleveland, Ohio. P. JUSTUS.

The growler at the left is designed for testing armatures up to about 4 in. in diameter. The growler at the right will take armatures up to 30 in. in diameter.



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Starting Trouble with Motor-Generator Set—In starting a synchronous motor-generator set the motor field is first short-circuited by the double-pole, double-throw, quick-break switch, which is provided with a short-circuiting resistance contact that closes just before the switch is opened from one direction and opens just before the switch is closed in the other position. The motor is started and comes up to speed on 2,000 volts; the field switch is then thrown to obtain excitation from the 250-volt bus. The running voltage of 6,600 volts is then applied. When the field switch is thrown from starting to running positions there is a bad flash between the hinge clips and the short-circuiting resistance jaw. What is the cause of this flash and how may it be avoided?

Pittsburgh, D. W. B.

In answer to D. W. B.'s question in the November issue, I believe he will find that his trouble is due to the short-circuiting resistance being removed from the field circuit before the field excitation is applied. I do not quite understand the statement in which he says, "the double-pole, double-throw, quick-break switch . . . is provided with a short-circuiting resistance contact that closes just before the switch is opened from one direction (presumably when the field is opened) and opens just before the switch is closed in the other position."

It looks from this as though the switch should make contact with the 250-volt clips before the short-circuiting resistance is disconnected from the field winding.

The first point to check would be the positive closing of the switch when the field is excited, for if the switch were stalled momentarily and the circuit reopened for a moment, the self-inductance of the field would undoubtedly cause an arc at the clips. Eventually this might cause the field insulation to become punctured.

Suppose that the switch closes properly, but that the short-circuiting re-

sistance is removed from across the field before the field is excited from the 250-volt bus, as was stated in the question. The motor is supposed to be up to speed, or practically up to speed, at 2,000 volts. If the motor is actually up to synchronous speed at this voltage, there would be no flashing, disregarding the fact that the application of the exciting voltage might produce a flash as stated above. In starting a synchronous motor, the field winding acts as the secondary of a transformer and at the beginning of the starting period, when the slip is greatest, a very high voltage would be generated in the field, depending upon the frequency with which the magnetic field cuts the motor field turns, and also upon the ratio of the number of field turns to the number of armature turns. This voltage decreases as the speed increases, the slip decreases and the frequency of the m.m.f. acting upon the field turns decreases. Some idea of the voltage generated during this period may be had from the fact that A. I. E. E. standards require an insulation test of 2,500 volts to ground on the field of the machine in question. Now suppose that the machine were not up to speed. It is evident that current will be flowing in the field windings, the amount depending upon the speed of the machine and the value to which it is limited by the short-circuiting resistance. If under this condition the short-circuiting resistance were removed from across the field before the field circuit was closed to the 250-volt bus, a bad flash would result. If flashing is caused from this source it may puncture the field windings, as the voltage at the time the circuit is opened will likely be much higher than the voltage caused by the transformer action due to the self-inductance of the field. Fields of machines designed to start without short-circuiting resistance are required to stand a test to ground of 5,000 volts.

Therefore, I believe that if D. W. B. will adjust his field switch so that the short-circuiting resistance remains across the field until it is excited, look to see if the resistance can possibly be opened due to a jar when closing the switch, and check the mechanical operation of the switch, he should remove his trouble. He might also check up on his rheostat setting and try cutting in more resistance in the field circuit for starting than he uses at present, adjusting the field so that the motor will operate at unity power factor after the running switch of the motor has been closed.

Toronto, Ohio. HERBERT KING.

* * * *

In reply to D. W. B. in the November issue, he does not state the size of his motor-generator set, but gives the correct method of starting sets of the usual size. However, it is often the practice with large sets to short circuit the field through resistance, close the starting switch until the highest attainable speed on that tap has been reached, and then close the running switch, at which time the motor should be very near synchronism. The last operation would be closing of the field switch and making the necessary rheostat adjustment. Closing the field switch at this time causes the motor to pull immediately into step with the system.

It is possible that the flash mentioned is the result of the frequency of the induced field current caused by the rotor not being as near synchronism as D. W. B. thinks it is. This current is extremely high at first contact and decreases as the speed of the rotor, with its corresponding frequency, approaches the frequency of the system.

If D. W. B. will obtain a high-grade indicating tachometer and correctly note the speed before throwing in the field switch he can obtain a good idea as to whether or not the above condition exists.

West Allis, Wis. E. J. MORRISSEY.

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In answer to D. W. B. in the November issue, the trouble you are experiencing is due, if I understand correctly your description of the switch, to burrs in the hinge mechanism. Possibly these are behind the spring washers where they are not noticeable. Such burrs are usually of high resistance and would cause the short-circuiting resistance to be partly opened.

Most of these types of switches have extension fingers with high-resistance carbon contacts. If the switch in question has such contacts it is possible that they are not making contact first when the switch is closed and last when it is opened.

It is also possible that there is some trouble, such as a short circuit or other defect in the short-circuiting resistance which permits the passage of more current or a higher voltage than the switch is designed for.

I hope that these suggestions will be of some help to D. W. B.

NICHOLAS J. WEISS.

West New York, N. J.

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Answering D. W. B.'s question in the November issue, his description of the trouble would seem to indicate that the motor is not up to full synchronous speed when the field switch is thrown into the running position. An ammeter in the stator circuit will show definitely when synchronism is reached by falling back to practically zero, with no load on the set. The fact that there is a flash when the switch is thrown from the short-circuiting position would indicate that potential is being induced in the field; this would not be the case if the machine were running at synchronism. The description of the trouble is too limited to make a definite recommendation, but I suggest that the speed of the set be checked at its starting voltage to make sure that it is up to synchronism. If this is found to be the case a slightly higher starting voltage may solve the difficulty, or the amount of field resistance in circuit on starting may be adjusted. It may be that the resistance in the field circuit during starting is not correct and a few tests would readily show whether this is the case. It is assumed that the machine is wired correctly.

C. OTTO VON DANNENBERG.

The J. G. White Engineering Corp.,
New York, N. Y.

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Trouble with Collector Rings of Turbo-Generator—We have a 2,300-volt, 60-cycle, 750-kva. three-phase, 3,600-r.p.m. generator driven by a steam turbine. We are experiencing trouble with one of the collector rings carrying direct current for excitation. This ring develops flat spots and what appear to be burned places all around it. The other ring has a fine polish without these spots and flat places. We changed the leads from one ring to the other and the spotted ring was trued up and polished. Then the ring that was first in good shape developed spots and flat places in the first two days after the leads were changed. The brush tension and brushes have been checked and we do not believe that the trouble is due to the brushes, as we are using the manufacturer's brushes. The proper exciting current is maintained and the rings seem to be true, although two years ago one of the rings became very hot and had to be reground as it was a little out of true. These rings are subject to much coal dust and oil vapor, but as the different rings spot up and have flat places all around them at about the same distance apart with the changing of the leads, I do not believe it is due to dirt. I should like very much to hear from others who have overcome trouble of this sort.

Zeigler, Ill. E. P.

As a possible suggestion of the cause of E. P.'s troubles as cited in a recent issue, I might relate our own experience with a 937-kva. turbo-generator with direct-connected exciter.

We had similar trouble and remedied it by turning the rings down true, purchasing an extra hard brush and increasing the pressure slightly on the new brushes.

The theory that I advance for this trouble is this: The ring on the negative side would always be the one affected. This brush would leave a slight deposit on the ring with every revolution and turning at 3,600 r.p.m. it would not take more than a few seconds to cause the brush to actually break contact with the ring, which causes the ring to burn and flatten out. In the event that the rings have to be turned true this should be done with the unit running at its rated speed; otherwise the centrifugal force on a ring of large size will tend to flatten it when turning at high speed.

We made the change to Electro-Nite Carbon Co. brushes on April 17, 1924, and since that time there has not been the sign of a spark on our rings and the unit runs at 25 per cent overload almost continuously.

The fact that one ring is light and the other dark in color is due to the negative brush eating away, leaving a dust deposit on the ring.

Rock Island, Ill. W. J. PARK.

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Replying to E. P. I had a similar experience with a smaller machine. It was a motor-driven generator that supplied the energy for repulsion-induction motors driving a large print shop. In this case both rings would become spotted and flat and, in a few days, the flashing would become so bad that the rotor would have to be removed and the rings turned in a lathe. Repeated turnings did no permanent good, although on each occasion there was temporary relief. The metal of the rings appeared to be flawless and checking of the balance of the rotor indicated it to be perfect. The outfit had not yet been accepted by the customer, who was beginning to get restless and expressed justifiable apprehension as to how many turnings the rings would stand.

On the next, and final, removal of the rotor to have its rings trued, it was

returned to the manufacturer who tested the rotor on the ways and found the static balance of the rotor to be good. Upon removing the rings and testing the rotor balance without them, however, the balance was found to be off; and a check of the rings showed that their balance was considerably off. Accordingly, a new collector ring unit was obtained and carefully balanced by itself on an arbor. Then the balance of the rotor without the collector ring was perfected. Finally the balanced ring was installed on the balanced rotor and turned after a check of the balance of the complete rotor indicated it to be perfect. After installing this rotor, no further complaint was made.

Brooklyn, N. Y. J. A. HORTON.

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In a recent issue E. P. recites some troubles with the rings of the rotating field of an alternator. From his description it is evidently either the positive and not the negative, or the negative and not the positive, brush that continually burns.

Several brushes placed round the ring would probably help. These brushes should be in parallel, so that the current enters or leaves at several points of contact. It is also possible that a ring of different composition would give better results.

It seems to me that the manufacturer should be held responsible for this trouble. It is a question of design and should be remedied without charge by the manufacturer of the machine.

Boston, Mass. EDWARD A. GIBBS.

* * * *

In a recent issue E. P. describes trouble with the collector rings of a turbo-alternator. I suggest that his trouble is due to vibration, aggravated by the effects of polarity. Even if the rings are first turned and polished and the brushes fitted as accurately as possible, small sparks will be formed, nevertheless, between the brushes and rings, owing to vibration and lack of sufficient flexibility in the brush rigging to compensate for this. Even when great care is taken in fitting brushes, the fit is far from perfect and under high ring speed sparks are certain to form between all the brushes and the rings.

Many years ago I had charge, along with several other makes of generators, of a Thomson-Houston A6 alternator which had in its armature, in addition to the regular 1,110-volt, a.c. winding, a low-voltage winding for excitation purposes. The current from this winding was quite heavy and was carried by two wires through a lengthwise hole in the center of the shaft to a rectifying commutator on the end of the shaft, outside of the bearing. As the shaft was slightly sprung the brushes vibrated excessively with attendant sparking. The commutator blackened and burned flat only under the positive brushes, and suffered more than the brushes. Under the negative brushes, the commutator had a good polish, but the brushes suffered.

I had already observed that when throwing a d.c. switch under load, burning, due to the sparks formed, is always worse on the positive side. I concluded that this action explained the trouble with the commutator brushes on the alternator. From these observations, I am inclined to believe that the sparks formed in E. P.'s case soon develop into arcs which burn the positive ring flat as described and also have a more or less detrimental effect on the negative brushes. The fact that the burning was shifted to the other ring, which ordinarily does not give trouble, when he changed the leads and consequently the polarities, seems to bear out this idea. I surmise that his rings are of either cast steel or else a fine grade of chilled cast iron. I would suggest that he grind the rings true in the running position with a portable grinder and carefully refit the brushes; then at intervals of a week or so reverse the leads and he will find that his trouble is considerably reduced. Of course, the cause of vibration should be located and removed, even if the use of a modern balancing machine is required.

We have a turbo outfit which behaves about like his does and if we had to use it much we would have it balanced, but as it is we manage to get along with it. This machine has steel rings and multiple brushes which give good flexibility but not enough to eliminate trouble entirely. We also have an alternator which is direct connected to a 200-r.p.m. engine. This has a revolving field fed through multiple brushes on steel rings. The peripheral velocity of the rings is low, compared to that of our turbo rings, and I can honestly say that since this machine was started August 1, 1908, not a thing has been done to either the rings or brushes at any time. The original brushes are still in use and giving excellent service and the rings still preserve their original polish. This can be ascribed to the low peripheral speed, absence of vibration and great flexibility in the brush rigging.

We also have another turbo outfit which was started in the Fall of 1914, and beyond wearing down, the rings on this machine are in good condition for the above reasons. There is an entire absence of vibration, although the speed is quite high, and another favorable condition is that the rings are of copper, designed for the purpose. If E. P.'s rings were made of copper, his troubles would be less, all other conditions remaining the same. Even if one of his rings were made of copper, and always kept positive in polarity, his troubles would be less. This is reasonable when one considers the remarkable service given by the copper electrodes in the magnetite arc. I think that collector rings should always be made of copper or a copper alloy, as these have good wearing qualities as well as the ability to resist the detrimental effect of the arc formed in conjunction with high speed and carbon brushes, which do not always go well hand-in-hand.

Some years ago the Wirt Electric Co., Philadelphia, Pa., sent us some special metal brushes which I found were not suited to the use we had planned to make of them. Rather than scrap them, I used them on the collector rings of our alternator, with exceptional results. To this day, I would prefer them to carbon brushes of any sort.

In addition to the possible causes mentioned above, of E. P.'s trouble, I might suggest lack of homogeneity in the ring metal as a cause of his trouble, although I am inclined to think that this is not the case.

Chief Electrician, HENRY MULFORD.
Patchogue Electric Light Co.,
Patchogue, N. Y.

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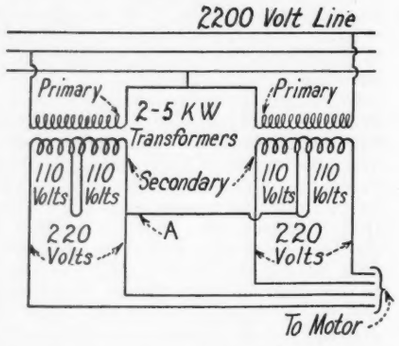
Trouble in Operating Two-Phase Arc Welder Set on Three-phase Circuit—I had occasion recently to operate a two-phase, four-wire, 220-volt, 60-cycle, 1,800 r.p.m. 5-hp. Lincoln motor, which is direct connected to a Lincoln welding generator on a three-phase, 2,200-volt, 60-cycle circuit. The transformer connection shown was tried. I found that the motor would start but in a short time would get very hot. The wire at *A* was cut and then the motor did not heat so much, so that by stopping the machine about every hour and letting it cool off I was



able to do the welding, but too much time was lost. I wish some of the readers of INDUSTRIAL ENGINEER would tell me if this connection is correct, and if so, what causes the motor to heat.

Tyrone, Pa. H. L. F.

In answer to H. L. F.'s questions in a recent issue the connection at (A) in his diagram should have no effect on the heating of the motor unless the motor windings are interconnected, either intentionally or by both windings being grounded (assuming that the transformer secondary is ungrounded), thereby forming an interconnection.

The voltage distribution with (A) connected as shown in his diagram is indicated in Fig. 1. If the motor is clear of grounds and not interconnected between phases, the voltages between (A) and (D) and (B) and (D) will not cause current to flow in the motor windings. Should, however, the winding be interconnected, say at (O), the voltage between (B) and (D) will cause current to flow at 292 volts in windings (HO) and (OF) of the motor. Heating would also be caused by reason of the phase angle being changed from 90 deg. to 120 deg.

With connection (A) cut the connection at (O) would not cause heating of the winding. The heating noted under this condition would be due to phase displacement only. It is evident that H. L. F. was confronted with a condition over which he did not have control and it was "up to him" to do the best he could with the equipment available, which was probably standard 10-to-1 transformers.

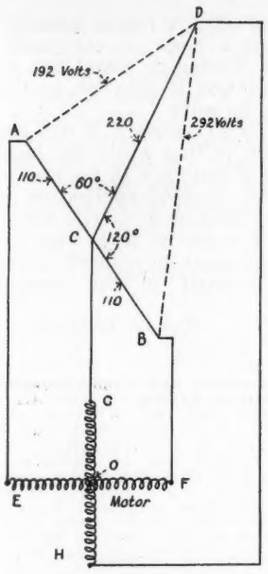


Fig. 1—Voltage distribution to motor windings with connection employed by H. L. F.

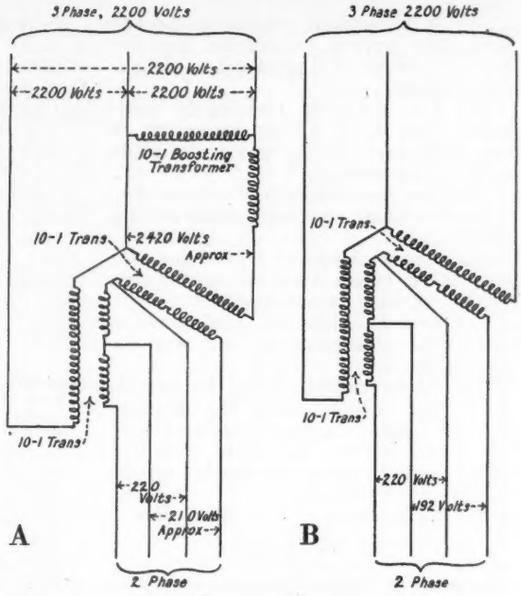


Fig. 2—Suggested connection for operating a two-phase motor from a three-phase supply. In (A) a small booster transformer is used to raise the voltage in one leg.

If the transformers had been connected in open delta on both primary and secondary sides and the motor connected as shown in (B) of Fig. 2, the two-phase currents would have been 90 deg. apart, but one phase would have had 13.4 per cent lower voltage. If a small transformer (approximately 10 per cent of the capacity of one of the main transformers) had been connected as in (A) of Fig. 2 to boost the applied voltage on one leg as indicated, the two-phase voltage would have been as shown, with a very slight displacement of the phase angle.

The suggestions illustrated in Fig. 2 are made on the assumption that transformers available were standard 10-to-1 ratio. If one transformer were 9-to-1 ratio the boosting transformer would not be required. With the connections shown in (A) or (B) of Fig. 2, the motor would still heat if both windings were grounded or interconnected.

Wilmington, N. C. CHARLES R. SUGG.

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Should Coils Be Purchased or Made in the Repair Shop?—We have in our plant about 1,000 motors ranging from 3 hp. to 100 hp. Roughly, one-third of these are older-type motors, while the remainder are of modern type. We have our repair shop, but so far have not attempted to wind our own coils. There is a feeling that we should do this, but before making any decision I should like to get the opinions of readers of INDUSTRIAL ENGINEER on the feasibility of doing this work. Will it pay us to do it? Can anyone give me some idea of the nature and approximate cost of the equipment needed?

I shall be very grateful for any information or suggestions you can give me.

Chicago, Ill. L. A. M.

The question by L. A. M. in the December issue, may be answered by citing the writer's experience in establishing a coil-winding section in the electrical department of a large industrial plant with which he was formerly connected. The first coil-winding equipment was put in about seven years ago at a time when about 700 motors were installed; at the present time there are about 1,500 motors in that plant.

The reasons for installing this equipment were: (1) A large stock of factory-made coils were of necessity kept on hand and after a year or so on the shelf the coils became brittle and the varnish would crack when the coils were put into a motor, thus causing an early insulation failure due to the entrance of moisture and oil into the coil. (2) Often, deliveries can not promptly be made from the factory and if several motors failed, all of the same type, serious delays would result. (3) The interest charges on several thousand dollars worth of rapidly-depreciating factory-made coils are a large item of expense, compared to the storeroom charges on about one-fourth the same amount of money invested in an equivalent stock of double-cotton-covered magnet wire. The amount of varnish and other supplies used is relatively small. Labor charges accumulate only as the coils are made up and put to work.

It is sometimes pointed out that a large amount of overhead should be charged against the coil-making costs. This is seldom the case in an industrial plant as about the same amount of factory space is occupied by factory-made coils as is necessary for the combined magnet wire storage and coil-making shop. Supervision is furnished by the repair shop foreman and the overhead necessary to be added is negligible.

For handling the repairs on 1,000 motors the equipment suggested would include one lathe-head-type, loop coil winder belted to a motor of about 2-hp. rating; one hand-operated coil spreader or former; two shallow varnish dipping tanks with drain racks; and one sheet metal or brick baking oven with about 2½ in. of heat insulation. The heat may be furnished by a gas-fired, convection-type heater, the products of combustion being piped outside of the building. The ventilation of the oven is important in order to provide oxygen to oxidize the varnish. The baking temperature should be maintained at a constant value suggested by the varnish maker. Considerable information on this subject has appeared in previous issues of INDUSTRIAL ENGINEER.

After a careful inspection of various motor manufacturers' plants the following coil-winding practice was adopted and has been in continuous use for a number of years: Double-cotton-covered magnet wire is used for making the straight, hair-pin loop coil. The coil is bound at intervals with lead strips and removed from the winder. The lint is burned off by quickly passing the coils once over a small gas flame and they are dipped in a fairly heavy, black, elastic baking varnish and allowed to drain. The coils are then placed in the baking oven and remain at the proper temperature for about 12 or 14 hr., care being taken not to overheat the varnish, which becomes brittle under such treatment. The loops are then spread or formed to a diamond shape and taped with a half-lapped layer of empire tape and a half-lapped layer of linen tape. Following this the coils are singed and dipped in a clear, elastic baking varnish and baked. This latter dipping and baking operation is repeated two or three times, until the coils present a smooth, glossy and continuous film.

The cost of coils made in the industrial plant will vary from one-third to two thirds the cost of factory-made coils, depending on the size of the motor, local labor costs and the expertness of the operators, who should preferably be women. The quality of the work should be equal to that of the factory coil and in some cases exceeds it, while for a large plant the economy is unquestionable.

As regards the cost of the equipment, a number of satisfactory outfits are now on the market, but quotations will have to be obtained and the cost estimated for each installation.

Alcoa, Tenn. J. ELMER HOUSLEY.

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Answering L. A. M. in the December issue, the making of coils is one of the most important steps in the process of rewinding d.c. or a.c. motors; in fact a good set of coils is the foundation upon which a long-life, rewind job is built. By a good set of coils I do not mean coils that look nice, but those in which have been incorporated all the best features known. That includes the best of insulation and wire, applied in such a manner as to withstand the hard knocks of service.

To meet the above conditions requires that the coil-manufacturing equipment installed must be of the best, as well as the material carried on hand. Magnet wire for example, comes in a variety of sizes, and types of insulation. Thus, we have round, square and ribbon wire, and the insulation on the wire includes single-cotton-covered, enameled, single-cotton and enamel, double-cotton and enamel, and asbestos-covered. In a great majority of cases the wire sizes will be duplicated in differ-

ent insulations, or in round and square. This means that the larger the plant the greater will be the amount of money tied up in wire. Then we have insulating material, consisting of cotton and linen tapes of different widths and thickness, treated tapes of at least two widths and grades, and mica tape. Then comes insulation in sheet form for coil wrappers; this includes mica and fish-paper, pure flexible mica, and treated cloth in the yellow and black grades. Also we require three different grades of insulating varnishes, as well as insulating glue, twine and flax cord. The majority of this material deteriorates with age and if not used within a reasonable time it becomes hard and loses its maximum insulating qualities.

But what is more important is the type of man available to take care of the coil department. This man should know, in fact must know, how to design and lay out any type of coil so that it will fit into the proper slots and have the proper end space and shape, so as to eliminate pounding a finished coil to shape. The coil man must know the principles of a.c. and d.c. windings; he must know what insulating material is available and its good and weak points and how to select the various items that make up a coil, to withstand different applications.

To illustrate, I have in mind a case where we had a large d.c. armature to repair. It had four conductors per slot and these conductors were shaped and joined together with clips at front and rear to form a winding that was the equivalent of a 2-turn coil, 2-circuit, wave winding, but each coil consisted of eight conductors and had three soldered joints. The coil man figured out the winding and made a 2-turn coil with one lead on top and one on the bottom, which eliminated the soldered joints and saved considerable winding time. What is more important however, it eliminated trouble that occurred from time to time due to the soldered joints. This was an advantage that was well worth considering.

From my 15 years of experience in repairing all kinds and makes of electrical machines, I can say that the grade of work put into a coil determines the life of that particular rewind job. This applies to the simple mush coil as well as the more elaborate coils.

The following are a few of the details that insure good coils. This list can be used for checking purposes in plants that make or intend to make their own coils, to determine how close they come to a grade A 1 coil.

(1) Are all materials used in the coils purchased according to exact specifications, thus insuring the best of everything?

(2) Are all coils wound in such a manner as to guarantee that all wires will be in proper relation to each other, using special tools or forms if necessary to meet above conditions?

(3) Are the points most susceptible to trouble—such as, crossovers, corners, curves, angles and points where the leads leave the coil—reinforced for insulation, strength and rigidity?

(4) Are the leads reinforced with extra insulation and the extra insulation firmly secured to the coil, and the leads reinforced to prevent slippage?

(5) Is it standard practice to dip the coils after pulling or shaping, and before insulating, in a good grade of baking varnish?

(6) Are the coils thoroughly insulated; that is, is the insulation put on the coils and not in the slots while winding the machine?

(7) Are the coils given a final dip, after insulating, in a high-grade baking varnish?

(8) Are the leads of all coils, a.c. or d.c. tinned before they are given over to the winding department?

(9) Are the coils inspected between operations and given a final test for shorts, etc.?

The above points should be considered when contemplating the installation of a coil-winding department and, as stated before, the more attention that is paid to them, the greater will be the life of rewind jobs.

Wilkinsburg, Pa. A. C. ROE.

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Meaning of Motor Nameplate Data—Can some reader tell me what "Open Hp. 10, Amps. 75—Closed Hp. 5½, Amps. 43," means in the case of a General Electric, d. c., compound-wound motor which has the following nameplate data: No. 95790, Form B, Speed 650, Volts 115, Open Hp. 10, Amps. 75—Closed Hp. 5½, Amps. 43. Pat'd Feb. 14-88 up to Jan. 31-99.

Mazatlan, Sinaloa, Mex. J. C. L.

Referring to J. C. L.'s query in a recent issue, the motor in question is sometimes equipped with small cast-iron plates which cover the openings in the endshields and make it an entirely-closed type. As the capacity of a machine is limited by the temperature reached by its windings, it is obvious that the heat would be more readily dissipated in the case of an open-type motor than with a closed type; consequently the rating will be higher.

In the open type there is a constant current of air through the windings caused principally by the rotation of the armature, warm air being replaced by cool air from the outside. Since this is not possible in the enclosed type, the allowable temperature rise would be reached at a much lower current density in its conductors; hence the reduced rating. In an attempt to facilitate the dissipation of heat in enclosed types, manufacturers often resort to radiating fins which are either cast integral with, or riveted to, the frame and end-shields. To the writer's knowledge a certain frame with a given winding often has a rating 100 per cent higher when it is of the open type, than when it is of the completely-enclosed type. The double rating of machines was formerly more in use than at present.

The A. I. E. E. specifications, June 28, 1916, state that:

"An open machine is either of the pedestal or end-bracket type where there is no restriction to ventilation other than that necessitated by good mechanical construction.

"An enclosed machine is so completely enclosed by integral or auxiliary covers as to prevent a circulation of air between the inside and outside of its case, but not sufficient to be termed airtight."

Denver, Colo. EDWARD H. HAUSLER.

In reply to J. C. L.'s recent question, in some plants a motor is completely enclosed in a wooden or metal box so that the ventilation is shut off, or the end bells may be solid.

If a motor is so enclosed, it will get as warm when pulling a 5½ hp. load, say, as it would pulling a 10 hp. load in the open. The practical application of the nameplate data on J. C. L.'s motor is, that if the motor is to be run enclosed, the load must be reduced to approximately one-half of the normal open rating.

Peoria, Ill. GEORGE RINGNESS.

* * * *

Grounding Secondary of 3-Phase, 220-440-Volt Distribution System—I wish some reader would tell me whether the secondary of a three-phase distribution system for 220-volt and 440-volt motors should or should not be grounded? Why? The Standard Handbook says: "The grounding of secondaries up to 150 volts has been required by the National Electrical Code since 1913. There is some doubt as to the advisability of grounding secondaries when the difference of potential between any wire and ground is higher than 250 volts, owing to the possibility that shocks from such a system may prove fatal." How could a person receive a shock from a grounded secondary system when the conduit inside of the building is also grounded? Would not trouble at once reveal itself? I shall appreciate it if you can enlighten me on the why's and where's of this subject.

Orlando, Fla. H. C. M.

H. C. M. asked an interesting question on the grounding of three-phase secondary systems carrying 220 or 440 volts. However, I think that he has answered his own inquiry of "why?" It is the practice hereabouts to do as he states; that is, ground no secondary over 230 volts because of strain on the insulation of the conductors.

As he says, a person cannot receive a shock from a grounded secondary system when the conduit is also grounded, unless the ungrounded wire is touched, or the ground wire has become disconnected.

Boston, Mass. EDWARD A. GIBBS.

* * * *

In answer to H. C. M. in a recent issue, the secondary of a three-phase, 220-440-volt system should be grounded for the personal safety of operators, although grounding is not compulsory, only optional, by the Code rules.

If the primary high voltage should break down its insulation and cross with the secondary winding there is a possibility of an operator getting a fatal shock from ungrounded apparatus, whereas, if the secondary were grounded, the primary fuse, on the power-house side, would likely blow, or the detector show a bad ground.

On the other hand, grounding the secondary increases the fire risk, for with one leg of a 440-volt line metallically grounded, if the other leg breaks down there will be a short circuit, which at this pressure will likely start a dangerous arc.

One way of handling the situation is to not ground the secondary, but to rely upon a ground detector located on the main switch-board. If lamps are used for this, connect them across the main secondary feeders permanently. If a voltmeter is used, arrange the connections so that a testing plug can

be inserted. Testing should be done frequently, so as to discover a ground as soon as possible.

Lamps used as a ground detector make a real good tell-tale, as they will show a ground steadily until it is removed; also, a "make and break" ground will show a repeated flicker, which is very noticeable. Lamps cannot however show the voltage of any ground.

The voltmeter detector can be used on only one leg of the system at a time, and although it is not as conspicuous in action as are lamps, it will indicate the exact voltage of any ground.

New Britain, Conn. H. S. RICH.

* * * *

In answer to the question asked by H. C. M. in a late issue of INDUSTRIAL ENGINEER, in practice nearly all secondary distribution systems are grounded, except secondary systems operating at high voltages. The reasons for grounding are: (1) To minimize life hazard. (2) To short-circuit static. (3) To insure continuity of service. (4) To provide a ground-detector connection.

The objections to secondary grounding are: (1) An accidental ground on a secondary conductor (if of opposite polarity to the permanent ground) may and probably will, interfere with the service. (2) With the permanent ground on the secondary circuit, if the ground wire is connected to one of the outside wires of the secondary system, there then exists between the other wire of the circuit, the conductor of opposite polarity, and the ground the full voltage of the secondary circuit. (3) Grounding of the secondary circuit may cause difficulties when tests are being made. (4) Permanent grounds increase the expense of installation.

The reason why secondary grounding of systems of 150 volts or less decreases life hazard is that an accidental cross between the primary and secondary of a transformer may cause a voltage equal to that of the primary circuit to exist, if the transformer secondary is not grounded, between the ground and any current-carrying parts of the secondary system. This is the case if there is a ground, permanent or accidental, on the primary. Even if there is no ground on the primary there may be electrostatic capacity enough to cause danger to any one standing on or in electrical connection with the ground, and touching any unguarded current-carrying parts of the secondary system.

The Code does not require secondary systems of over 150 volts to be grounded for the reason that higher voltages between the ground, or grounded point, and any other point in the circuit are dangerous to persons standing on the ground or electrically connected to it and touching a wire of opposite polarity. In this case there need be no accidental cross on the primary.

If secondary systems of 150 volts or more are installed in conduit and the conduit is grounded, and effectively grounded, the above-mentioned dangers do not exist so long as there are no unguarded current-carrying parts. Trouble, as a ground on opposite polarity within the conduit tubing, would probably cause a current strong enough to blow fuses or trip the breaker protecting the system.

Concord, Mass. DONALD FERGUSON.

* * * *

H. C. M.'s question in a late issue deserves more than a perfunctory answer, as it brings up a number of points that must be settled by the operating man for each particular system concerned, with reference to the actual requirements of the case.

A direct reply to the question should, I think, be prefaced by some comments concerning the general subject of grounding. Grounding may be considered from the following three standpoints:

(1) Grounding to reduce the life hazard.

(2) Grounding to safeguard equipment.

(3) Grounding to improve operation.

(1) The desirability of limiting the maximum voltage to ground in circuits where it is possible for a person to come into actual contact with a live conductor is now fully recognized by all controlling bodies as well as operating companies. It is limited in the main to lighting circuits where burned-out lamps or fuses may be replaced by inexperienced persons who may readily come in contact with an exposed conductor.

The limit of 150 volts is in fact more or less arbitrary, as the exact voltage dangerous to life has not been definitely established. In up-to-date motor wiring where the switching and control equipment is always more or less, if not totally, enclosed the danger of direct contact is very remote. It is desirable, however, that the frame of each motor as well as the metal frames or containers of each piece of control equipment be well grounded, to protect anyone that might come in contact with them.

This applies especially to equipment mounted on an insulating supporting structure, in which case the connection of the winding to the frame or part of the circuit to the metal work might allow a considerable difference of potential to exist between frame and ground without any visible indication. Anyone touching the frame might, under certain conditions, receive full voltage to ground. If the frame were grounded this danger could not possibly exist.

(2) With an ungrounded system it is possible to have one conductor actually grounded for some time without any indications of trouble, but during that period the insulation may be weakened by the flow to ground of even a small current through partial grounds on the other conductors. Due to the poor contacts that usually exist in these cases, aided by moisture or semi-conducting dust, the insulation may char for some time and the ultimate result may be serious breakdown in the equipment. While this trouble is more pronounced at voltages above 250 it can readily occur at even lower voltages. Obviously, by solidly grounding such a system cumulative trouble can be prevented by making a ground noticeable as soon as it occurs.

(3) Supplementing section (2) the question of continuous operation is always paramount. A well-known stock argument against operating with a grounded system is the statement that a ground in any motor winding may cause an interruption of service. Experience indicates, however, that this is not the case, as grounded systems actually give less trouble. In fact the existence of a ground is immediately shown by the blowing of a fuse or the tripping of a circuit breaker, or other indication. As a result it is necessary to clear up any trouble immediately and also to give better attention to the condition of the motor windings, which in turn results in shorter delays and better service.

Coming now to the direct answer to the question, it is assumed that the installation is supplied with current from an outside source, although in general similar methods may be used for isolated plants.

For a 220-volt system the grounding can readily be accomplished by installing grounding transformers connected in star and grounding the neutral connection; this will give a maximum of $220 \div \sqrt{3}$ or 127 volts to ground, which is of course, well within the requirements of the National Electrical Code. In establishing this type of grounded system the secondaries of the grounding transformers should be connected in closed delta so as to reduce the impedance of the ground circuit to a minimum and allow the current to pass readily in case a bad ground should occur.

For a 440-volt system the grounding may be similarly accomplished, giving a maximum of 253 volts to ground. While this exceeds the value of 150 volts previously referred to the fact that the control equipment may be entirely enclosed and the frame of a motor solidly grounded makes the possibility of danger to an operator extremely remote. One of the largest electrical manufacturing concerns in this country has operated for many years with such a system without a single case of injury which could be attributed to shock due to the system used.

The question asked regarding the possibility of a person receiving a shock due to a ground inside of conduit when the conduit itself is grounded is answered by the foregoing discussion. It is not possible to receive any appreciable shock from a reasonably well grounded system, and the trouble gives a definite indication immediately when it occurs.

Summing up the matter, the following points deserve particular consideration: (a) Grounding a three-phase system establishes a definite maximum potential to ground, as compared with a varying potential for an ungrounded system, which potential may reach the maximum potential between phases. (b) An ungrounded system is an unstable one which can easily develop serious trouble because defects do not become evident, until they are quite serious.

In other words, there can be no serious objection to operating three-phase 220-volt and 440-volt distribution systems properly grounded.

C. OTTO VON DANNENBERG.

The J. G. White Engineering Corp., New York, N. Y.

Building Maintenance and Plant Safety

The object of this department is to give details of building maintenance procedure and best practice in safety work. Articles on ways of handling natural wear and tear or other depreciation, repair methods, rebuilding, extensions, cleaning and painting operations will always be welcome.

Two Ways to Get Longer Life From Eaves Troughs

EAVES troughs are more or less of a problem in building maintenance. If the runs are long, as they generally are, the difference in expansion between the metal trough and the building (especially if it has a concrete roof slab) is considerable. If the trough is suitably hung and braced, it expands more than the building, and leaks develop in the joints. Sometimes the expansion strains pull rivets or shear them.

We went over the eaves troughs at this plant recently, and riveted a piece of galvanized iron across each joint. This was fitted to the inside of the trough, and extended 10 in. or 12 in. each side of the joint. These pieces were riveted well and soldered at the ends. This arrangement has, we believe, added five or six years to the life of the troughs as the metal was perfectly good, excepting at the joints where expansion and ice strains had broken solder and rivets.

The outside was painted with a good metal paint, and the inside with an elastic roof paint. The cost of this repair was approximately 7 per cent of a new set of troughs. The job has transformed a long sieve into a real eaves trough.

A neighboring plant has solved a similar expansion problem by dividing the troughs into 50-ft. sections and grading with a steep pitch each pair of 50-ft. sections to a center downspout. The downspout is connected to a sewer-tile drain laid parallel to the building. This gives a downspout in the center of each 100 ft. of eaves trough.

The advantages are steep pitches, expansion well taken care of and longer life of the installation. Balanced against this is the extra cost of downspouts, which is a small percentage of the total building cost.

In new construction see that the trough specifications call for heavy metal, heavy braces, short lengths, good pitch, plenty of downspouts and a way to dispose of the water after it is off the roof. Keep the troughs well painted both inside and out, and while they may not be a thing of beauty, they will be a joy, for a long time at least.

Plant Engineer, Gardner Machine Co., Beloit, Wis. S. W. STEARNS.

Method of Preventing Rods From Turning With Turnbuckle

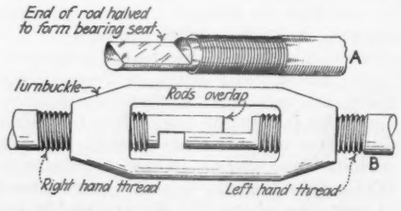
IN TIGHTENING turnbuckles, it is usually necessary to place a pipe wrench on one or the other of the two rods being tightened in order to prevent them from turning or being loosened from the connection at the other end of the rod.

If the ends of the rods are halved as shown at (A) in the accompanying illustration, they can be prevented from turning when assembled with the turnbuckle, as shown at (B).

When tightening or loosening the turnbuckle, the rods will now tend to turn together. They will not turn, however, for one rod or the other will tighten into the nut or socket on its other end and thus prevent rotation.

This is a simple idea which is easily applied to any turnbuckle, where the length of the rods is sufficient for threading and halving the end.

Washington, D. C. G. A. LUERS.



The ends of the rods in the turnbuckle are halved as shown at A.

When assembled as shown at *B*, both rods tend to turn together. This is not possible, however, because of the end connections on the rods and in consequence the rods do not turn, when the turnbuckle is moved in either direction.

Simple Method of Cleaning Sludge From Fuel Oil Tanks

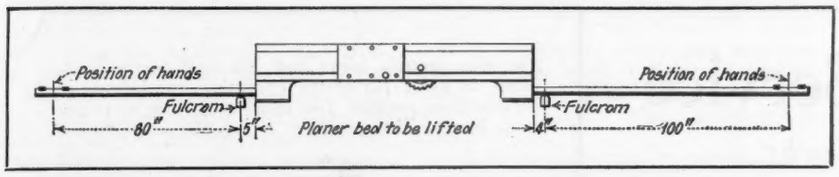
SLUDGE is a black, sticky asphaltic "end" contained in fuel oil. It emulsifies with water forming an incombustible mass in some cases, chokes strainers and pipe lines, carbonizes burners, causes smoke, and when used as a fuel for Diesel or internal combustion engines, jeopardizes the cylinder walls and valve motion by introducing sand or grit that is entrained. When cleaning fuel oil tanks and pipe lines everybody around the plant from the "Old Man" to the oilers are smeared with the black, sticky, smelly, oily substance. It is a disagreeable, costly job at best.

There are several methods now used to handle this proposition. The old-time method was to pump as much oil and sludge out as possible. Then the tank was opened and laborers in rubber boots with shovels, hose and buckets, scooped and bailed out the remainder. A wash-down with kerosene and brushes and a subsequent wiping out with rags followed. It was a long, hard job, expensive because the labor factor was the predominant cost, and dangerous because of the deadly gases contained within the tanks. This made it necessary to air the tanks even after filling with water for as long as 48 hr. after emptying.

The first advance came when high-pressure steam was introduced to the job. The heat of the steam served to lower the viscosity of the sludge and permit more complete emptying of the tank with pumps and bleeder lines. Then, too, the side walls and top were cleaned more or less by the heat and moisture of the steam.

Some of the large oil companies resorted to the use of naphtha after the tank was wiped down and subsequently re-distilled the naphtha. This was more effective, but the use of this material is prohibited in most plants, due to cost and fire hazard. Moreover, the tanks must still be wiped by hand.

With this in mind, engineers turned



How a heavy planer bed was weighed without the use of scales.

The weight of each end was found approximately by determining the weight required on the outer end of a lever, supported by a fulcrum, to balance the weight of the bed. The distance of the fulcrum from each end of the lever was known and when the weight required to balance the planer bed was determined the weight of the latter was calculated by simple proportion.

to lye. Here was a means of cleaning oil out without expensive hand wiping. Accordingly the tank was emptied and a hot, strong solution of "lye" (sodium-hydroxide), was pumped in and a steam line connected. After about an 8- or 10-hr. boil the solution was pumped out. The tank was much cleaner but here and there, particularly around seams and rivets, it was necessary to wipe it down. However, the strong caustic vapors made life miserable about the place; overalls fell to pieces, skin peeled off the men's arms and faces, and in some cases, "caustic boils" appeared in a few days.

Search was then made for a material that would either modify the alkali effectively or replace the use of caustic entirely, and be commercially practicable. Many materials that were found to be effective in the laboratory, were impractical because of cost of manufacture. Finally a method of using alkali was found, so that it would not cause burns nor poison sores, and yet was effective.

Briefly the process is as follows: A hot solution of 4 to 6 oz. per gal. of a special compound (International Chemical Co., Philadelphia, Pa.) is run into the tank. A live steam hose from a small portable boiler is inserted into the compartment and the whole mass boiled for one hour. During this time the sludge is loosened and emulsified and floats to the top. The condensing steam adds just enough water to the tank to cause this emulsion to overflow the vent pipe and thus carry away the loosened oil. At the end of the hour, the solution is transferred to the next tank or compartment and the process repeated. There are no objectionable odors. A flame may be carried with perfect safety into the tank as soon as it is emptied. The entire tank is clean; seams, rivets, corners—in fact, water-white gasoline may be carried without contamination.

The cost is extremely low; about 2 cents per gal. for the solution and a minimum of hard labor are required. There is no wiping; the tanks are simply boiled out and emptied. In the case of ships the time required for cleaning the tanks is reduced from approximately two weeks to one day. The saving in this case is large.

The same method may be used for cleaning tank cars as well as fixed tanks. In tank car cleaning one solution can be re-used on as many as seven to ten cars, depending on the amount lost in transfer, evaporation and otherwise. To clean pipe lines, it is only necessary to pump the solution through them. Where there is a circulating system, this is very simple matter, as the solution will not injure pumps, valves or strainers. The cleaning solution may also be used to clean up the floor, walls and pumping machinery.

Technical Division, W. B. CLARKE.
International Chemical Co.,
Philadelphia, Pa.

Using Lever to Find Weight of Heavy Machine Parts

OFTEN it is desired to know the weight of pieces that are too heavy for scales at hand or that are so located that they could not be weighed even if there were available scales of the proper capacity.

Complete machines or heavy castings are not readily moved about under the best of circumstances. The heaviest spring balances in ordinary use run only to 500 lb., while the average platform scale of the portable or pit type weighs up to 1 ton—these are useless for all but "light" machinery.

A knowledge of the weight of bulky parts is desirable for many reasons, such as, to prevent overloading floors, to properly fill out shipping forms, to build adequate foundations, and to safeguard men and handling facilities.

The worst kind of accidents have been caused by weak blocking, flimsily built supports, machines that have been raised with a bar or otherwise and, lacking proper balancing, have toppled over on an unfortunate workman, or parts that were being erected from scaffolding by main strength or suspended from frail slings. Not realizing the weights involved and the danger resulting from the least slip, millwrighting is carried on in this way and, when the slip does occur, the part always comes DOWN.

In the case of a new machine, weights may be obtained from the makers, but with one that has seen many years of service, there is generally no way to get the weight except by an actual scale reading or its equivalent. A computation by volume may be only an approximation because of inaccessible portions and irregular shapes which make the computation only a high-brow guess. When it comes to moving such pieces from floor to floor or out of a building, cranes and floors may show up their weakness and an accident result. It is not necessary to consider the heaviest equipment, in order to see how true this is. Machines about the size of a No. 4 Toledo press, a 20-hp. steam engine or a 40-in. planer will serve as illustrations. What would happen if 2-ton handling equipment were all that was available for moving these?

The lever provides a means of checking the weight of almost any piece up to 30 tons. With a fulcrum placed close to the part of unknown weight and a suitable lever, one or more men or a known weight can be placed at measured distances to balance the load. This procedure repeated at the two ends of a part will give the weight sufficiently accurately for all practical purposes. The calculations are by inverse proportion of the simplest kind.

The accompanying drawing shows how a planer was weighed. The machine was being rebuilt in the shop where it was used and one of the jobs was planing the ways on both table and bed. To do this, of course, the machine had to be entirely dismantled and the parts named had to be put on another planer. The table was estimated at 2 tons weight (from volume computation) and this was checked by lever also; this part was within the overhead handling facilities, it was known, but was checked anyway. But the bed was much heavier and it had to be lifted 36 in. from the floor and then moved sidewise to an adjoining planer. What was the weight of that bed? There were too many inside braces, rounded corners and too much core work to get anywhere near the volume by calculation. The simpler method, in any case, is as follows:

A bar of steel was picked out from the stock rack. Then, a block of suitable height for the planer bed's opening was placed between the feet and on this a piece of iron that had been ground off rounded on top. This iron block was placed at a measured distance from the point of application of the lever. The rounded top to the fulcrum is better than a flat surface because the flat top does not offer a definite measuring position inasmuch as the lever moves through an arc.

A 220-lb. workman did the "weighing." He knelt down and rested his whole weight on the free end of the bar, raising himself just clear of the floor in so doing. By successive trials, the position where his weight balanced that of the planer was found. On the drawing, the location of his two hands is shown by heavy black. When the balancing position was found, a measurement was taken from the center of the hands to the planer.

The calculation is as follows:

$$(220 \times 100) \div 4 = 5{,}500 \text{ lb.}$$

Or, by proportion: $220 : x = 4 : 100$. The results are the same in either case. The operation was repeated on the other end; the weight there was found to be 3,520 lb. Thus the weight of the machine part was definitely obtained as the sum of the two weights or 9,020 lb. This was accurate enough for our purpose and enabled us to arrange handling facilities that were both adequate and safe.

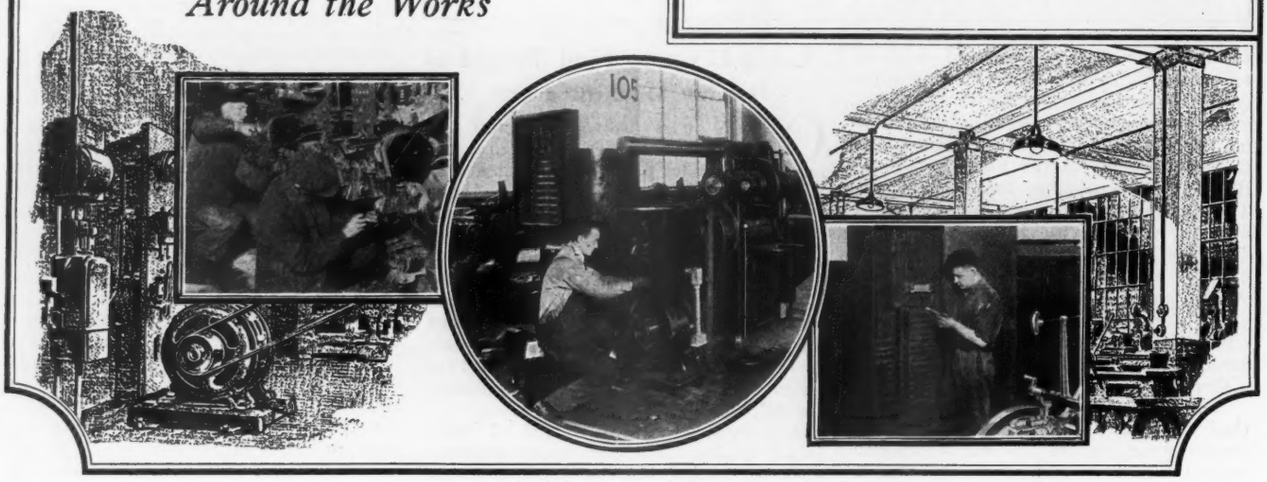
When the lever is used for weighing, it is important that it be placed in a horizontal position. If this is not done, a true measure will not be obtained. To arrange the lever in horizontal position, it is only necessary to provide suitable blocking under the fulcrum and to have it slightly "high" rather than low as the weight need be lifted only a half-inch, or thereabouts. Do not try to lift both ends of the machine at the same time as it may tip.

DONALD A. HAMPSON.
Plant Superintendent,
Morgans and Wilcox Mfg. Co.,
Middletown, N. Y.

Electrical Service

Around the Works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.



Method of Protecting Plug and Receptacle for Portable Machine

INSULATION of a portable sand cutter in a foundry presented a problem in selecting or designing a suitable plug and receptacle and mounting them so as to secure the desired flexibility of operation with the maximum protection from damage.

The sand cutter, which does as much work as four men cutting molding sand, operates 9 hr. a day. It is driven by a 7½-hp. motor and is supplied through a No. 4 line, in order to avoid a heavy voltage drop at full load. The wiring is all in conduit and power receptacles are located at convenient points around the foundry.

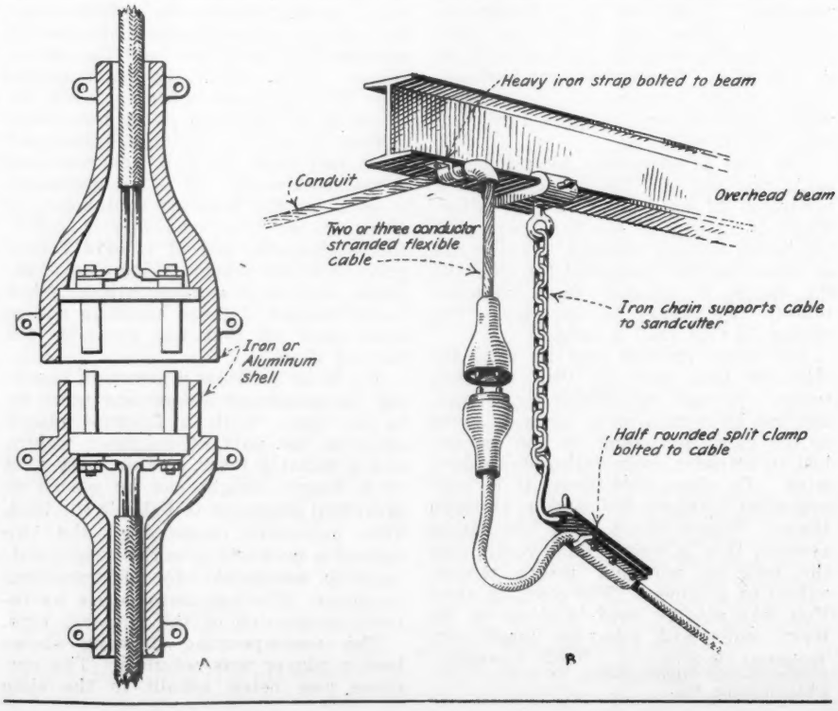
The flexible cable by which the sand cutter is connected to the power receptacle is carried over wooden pulleys to a small reel which is mounted on the sand cutter and driven by a chain so that it automatically pays out or reels up the cable as the machine moves. An adjustable brake band holds the reel just tight enough to prevent slipping.

The type of plug and receptacle shown in (A) of the illustration was adopted for use, and mounted as shown in (B). These plugs and receptacles are split and can be made with an iron, aluminum or hardwood shell. They are about 6 in. long and 3½ in. or 4 in. in diameter, depending on the material used.

Where the contact parts are of the pin-and-tube type, the pins must be tapered and the tubes split to insure tight connection. As will be seen, the receptacle is suspended from the end of the conduit, which is firmly fastened to the supporting I-beam, by a short length of standard, flexible cable. The plug is, of course, connected to the end of the flexible cable on the sand cutter. A half-round, split clamp is bolted around the cable about 3 ft. from the plug. One side of the clamp has a hole at one end to accommodate a hook attached to the loose end of a short length of stout chain which is suspended from a clamp fastened to the I-beam. By this arrangement the weight of the cable is supported by the chain, so that under no circumstances can the plug and receptacle be pulled apart, or any strain be placed on them.

Protected in this manner, the plug and receptacles have not given any trouble. The same scheme could be used to advantage on any piece of portable equipment which requires a heavy, flexible cable, or where there is danger of the cable being pulled.

Jamestown, N. Y. H. S. RICH.



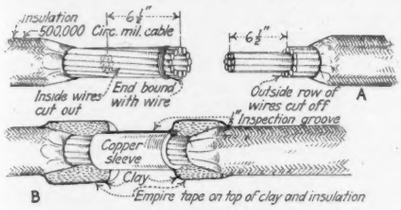
Details of plug and receptacle, A. In B is shown how the flexible cable is supported by a chain suspended from an overhead beam, thus preventing the plug and receptacle from being pulled apart.

Method of Making a Sleeve Splice on Heavy Cables

IN REVAMPING an existing system of cables behind a switchboard, some of the cables were found to be too short while others were a trifle long. The long ones could be cut off and lugs soldered to them, but the short ones had to be spliced out. There was no strain on the wires and it was decided that a sleeve splice would be the most adaptable. It would have good conductivity, have a fair tensile strength if the sleeve were of sufficient length and would not be too bulky when taped.

The ends of the cables to be spliced were prepared as shown at *A* in the accompanying illustration. As can be

seen the inside wires were cut out of one cable and the outside row of wires cut off from the other cable, thus making the left hand cable the female end of a joint. After the wires had been well cleaned and fluxed with soldering paste a wooden mandrel was inserted in the female cable and the loose wires



The strands of the two cables are cut and formed as shown at (A).

The male cable is then placed in the female and the joint encircled with a copper sleeve, as shown at *B*. The ends of the sleeve are calked with clay to prevent the melted solder from running out during the soldering operation.

were tightly bound with wire as shown. This was done to hold the wires tightly together after the mandrel was removed.

A copper sleeve was then inserted over this cable in the manner shown at *B* in the illustration, and the male cable inserted into the combination as is shown. When the sleeve is in place, the banding wire around the female cable may be removed. The sleeve should be long enough to extend 1 in. on both sides of the places where the wires were cut. This will hold the joint rigid and prevent it from breaking open when handling and bending the wires while working it into place after the joint is finished and taped.

The copper sleeve can be made from a piece of tubing. An inspection slot, about ⅛ in. wide should be cut through the entire length of the sleeve. In case a piece of tubing is not to be had conveniently, a piece of copper sheet 1/16 in. thick can be tinned on one side, cut to the proper length and width, and bent into shape.

The copper sleeve should be placed with the inspection slot on top. Clay was smeared around the edges of the sleeve to prevent the melted solder from running out of the ends of the joints, and varnished cambric tape wrapped on top of the clay and insulation to keep the latter from charring, and to prevent the clay from flaking off as the joint is dried out by the heat of the torch. The object in using varnished cambric tape under these conditions, is that it neither smokes nor flames up from the fire of the torch, which is a very desirable feature.

The joint was thoroughly heated and kept hot by two torches and melted solder poured from a ladle into the inspection groove of the copper sleeve. Even after the groove becomes full of solder, it is advisable to keep the torch on the joint for a little while, so that the solder will permeate the wire thoroughly.

The torches were removed and the joint cooled slowly by means of a damp rag placed on the under side. As the solder contracted, as was apparent by its disappearing from the groove, more solder was added from the ladle. This contraction will continue before the solder hardens, so that it may be necessary to add more solder two or three times. After each addition of melted solder, apply the torch again for a short interval so that the solder bonds and is homogeneous.

A little practice may be necessary to make a good splice by this method but it is well worth the effort.

Oakland, Calif. S. H. SAMUELS.

Method of Paralleling Alternators Coupled to Same Shaft

THE original installation in a small power house consisted of a 125-kw. alternator and a water wheel of double the power capacity of the generator. Later on the owners had the opportunity of purchasing second-hand an exact duplicate of the original generator, and installed it on the same water wheel shaft. For a while they used either generator on the load, but never used both at the same time as they were only supplying one circuit and the load did not require it. However, when the load, which was a small town lighting load, outgrew the one generator it became desirable to arrange the two machines for simultaneous operation in parallel in order to take care of the load.

The two alternators were mounted on opposite sides of the prime mover, and connected to the waterwheel shaft through couplings as shown in the accompanying diagram. Of course, the only thing to be determined was the exact mechanical relationship of the two fields in order to have them operate with a minimum cross current.

The bolts were removed from the coupling (M) which connects generator (A) to the waterwheel. The two halves of the coupling were then tied together with strings sufficiently strong to permit the alternator to be brought up to speed when the waterwheel was started. Alternator (B) was left permanently coupled to the other end of the shaft. The waterwheel was started and brought up to speed, and the fields of generator (B) and also of generator (A) were partially excited. The switch between the two machines was then closed, the machines pulled into step, and by this operation the relatively weak strings tying the coupling on alternator (A) were broken, leaving machine (A) running independently as a synchronous motor supplied by power from machine (B) running as a generator.

It was only necessary then to bring the voltage up to normal and adjust the excitation of either machine until the circulating current was a minimum. At this point the two machines were of course in correct phase relationship. A chalk line was then stretched across the flanges of the coupling at (M) parallel to the shaft and snapped against the coupling while the machines were running at normal speed. The machines were then stopped and three clearly defined impressions of the chalk line were found on the two flanges of the coupling. The chalk lines on the two flanges were then brought exactly into line and the couplings bolted together in the new and correct position.

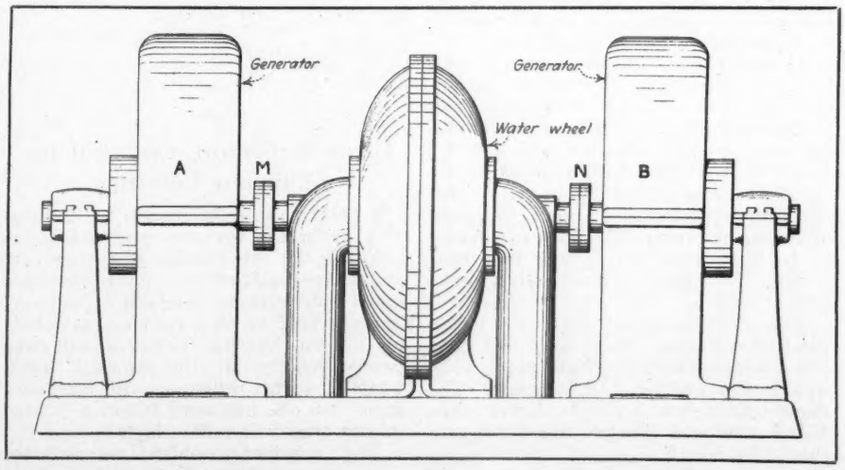
It was necessary to ream out the holes in one-half of the coupling in order to bolt it together in exactly the right position. In some cases it might be necessary to bore new holes in one-half of the coupling, as it is unlikely that the original holes would be found to agree.

These machines have been running in parallel with perfect satisfaction ever since and I believe that this was a very simple way of handling the situation, as practically no special equipment or instruments were needed.

President, R. S. HUNTINGTON.
Huntington & Guerry, Inc.,
Greenville, S. C.

The bolts were removed from the coupling at M and the two halves tied together with string.

Both machines were brought up to speed and paralleled. This operation broke the strings at *M*, but alternator *A* continued running as a motor supplied from alternator *B*. A chalk line was snapped against the coupling *M*, thus marking the position in which the two coupling halves should be bolted together.



Inspection and Testing of Oil for Circuit Breakers

IN a paper on safe operating and inspection practice for circuit breakers and starting devices, presented at the recent Safety Congress, held at Louisville, Ky., G. F. MacWilliams, electrical engineer of the Pennsylvania Coal & Coke Corporation, Cresson, Pa.,

gave the following interesting information on the inspection of oil switches and the filtering and testing of the oil used in them:

Some oil switches are often required to open circuits carrying currents much larger than those for which the switch is designed. The oil is placed in these switches to prevent an arc being formed when the current is interrupted. These arcs cause carbonization of the oil, which reduces the insulating characteristics and may cause trouble. Dust and dirt also enter the tanks and in many cases form a conducting material.

Whenever an arc is broken under oil the oil dissipates some of this heat and itself becomes heated. This causes an expansion of the oil and a certain quantity of air is expelled from the tank. When the oil cools and contracts, it causes new air to be taken into the tank. If this air contains moisture, which it nearly always does, fine particles of water vapor form on the sides of the tank and drop into the oil.

If much moisture and dirt is permitted to collect in the oil and tank, a heavy arc may cause the switch to explode. Switches of this type with vertical contact boards permit dust and dirt to drop into the tank rather easily, whereas horizontal boards prevent much of the dust from getting into the oil. Dust and dirt collect on the outside of a switch, due to the presence of oil which holds any floating particle of dirt which comes in contact with it. Dust and dirt in this manner form a conductor between the switch terminals and often cause leakage of current to ground or from one line wire to another.

To avoid accidents it is necessary, therefore, to keep the switch as clean as possible and make periodic inspections of all current-carrying parts and also of the oil. Sludge in the bottom of an oil tank may become so deep as to cause current to leak from one of the line wires to ground.

Depending upon the service rendered by an oil switch, the oil should be changed every month or every few years. In dusty, damp places it may be necessary to renew the oil every few months. In clean dry places it may be necessary to renew the oil not oftener than every four years. No set rule can be formulated, as the time will depend on the location and severity of the service. Every oil switch should be inspected at least once a year.

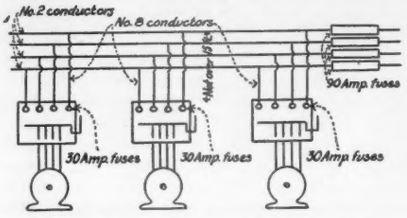
At our mines, unless a switch has been in abnormal service, it is inspected once a year. If moisture or sludge appears in the tank, it is cleaned out, the contacts adjusted and new oil put in. Any oil which appears to be satisfactory is tested before it is used. Oil that appears to be good is often, upon further inspection and test, found to be unsuitable for further use until filtered. For this purpose a filter press is provided.

New or filtered oil must not break down at a voltage less than 35,000 volts when tested between sphere gaps ½-in. in diameter and set 0.15 in. apart. The flash point should not be lower than 171 deg. C and the fire point not less than 178 deg. C.

Accessibility of Fuses Is Big Factor in Laying Out Power Circuits

IT HAS been the accepted custom for years to run a set of mains along the ceiling of a mill or factory and where it is necessary to branch off for a motor, to place a cutout or set of cutouts where the change in size of wire is necessary. At last "the powers that be" are seeing the light and the 1923 National Electrical Code reads as follows:

"Article 8, Section 808, paragraph D. —Automatic overload protective devices may be omitted at the point where conductors carrying the current



Fusing for power circuits where two or more motors are connected to the same mains.

of only one motor are connected to the mains, provided their current-carrying capacity is at least one-third that of the mains and the length of the conductors between the mains and the motor protective devices is not greater than 15 ft. and they are suitably protected from mechanical injury."

At last, under the above conditions, we can get away from the old method of getting a ladder and climbing up among a wilderness of shafting, pipes, belts, and the like, (and probably getting a nice static kick from the belts) simply to renew a fuse in a branch circuit.

From the accompanying diagram the advantage over the old methods of installation will be readily seen. In addition, under these conditions there is a saving of three complete sets of fuses. The life hazard has been eliminated and the troubleman can feel that when a fuse blows it is only a moment's work to replace it.

Time is saved in MAINTENANCE and cost is saved in INSTALLATION. Besides, a much better job is possible from the standpoint of good engineering practice and safety.

EDWIN V. LAMBERT.

Electrical Inspector,
Philadelphia Fire Underwriters' Assoc.,
Ardsley, Pa.

Clean Reflectors Essential for Efficient Lighting

ABOUT the only reason for buying reflectors for overhead industrial lamps is the expectation of saving just about one-half of the light that we know the bulb is producing; approximately half of this goes up, and half goes down. A clean reflector will save pretty nearly all the upward light, while a dirty reflector will not save any. No one has ever found any kind of dirt that will reflect light.

The greatest problem in reflector cleaning is accessibility and when we stop to consider what the reflector cleaner has to do to get at many of the overhead lamps, it is easy to understand how so much money has been lost—wasted—in industrial lighting.

Obviously, the most logical solution of this problem is to make the work easy and safe by installing overhead lamps on a safety lowering switch, operated from the ground by a rope or chain. Then, instead of doing any climbing at all the lamp cleaner pulls the chain, whereupon the lamp is automatically disconnected from the electric circuit and comes down free, and dead. The cleaning is thus done in safety, with convenience and efficiency, down on the ground. When the lamp is pulled up again it goes automatically back into the circuit and locks. This not only eliminates the climbing hazard, but also any electrical hazard, for the lamp cleaner is kept away from the electric circuit.

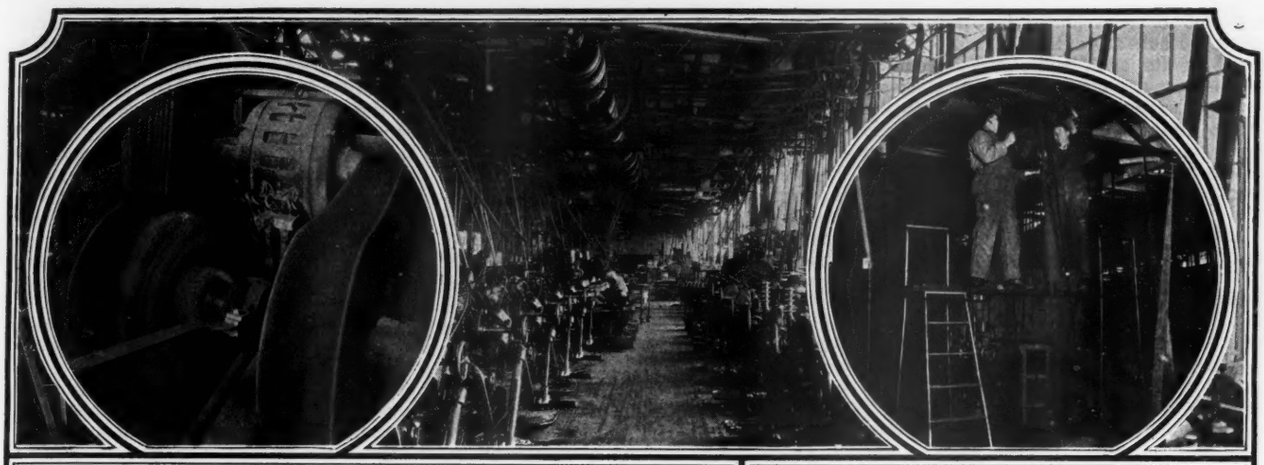
While the use of a safety lowering switch increases the cost of the installation somewhat, that is exactly true of the reflector, for it also adds to the cost of the installation. The reflector costs more than the bulb and does not produce any light—that is done only by the bulb—and only a clean reflector will save any light. Yet, if anyone today had a plant full of bulbs without reflectors it is reasonable to assume that he would not hesitate to spend whatever amount of money was necessary to put a reflector on every one of those bulbs. Why? He will not be producing any more light than he had before, and unless he keeps the reflectors clean he will not save any light.

The answer is that the public mind has now become educated to the "idea" of a reflector, just as the public mind has become educated to the idea of conduit, conduit fittings, fuses, etc., all of which add enormously to the cost of the installation, but the only question now is, "What kind?" So, while the safety lowering switch may add something to the cost of the installation, there is no more reason for omitting it than for omitting any other device that may be essential to the proper functioning of the lighting equipment.

If the bulb had been sufficient without the reflector it is a certainty that the reflector manufacturers would never have made any headway with their product. The combination of bulb and reflector will give marvelous results when new—while they are clean and bright and sparkling; but their efficiency falls off with every particle of dirt that accumulates. While it is impossible to prevent the dirt from getting on the lamps, we do not have to let it stay there, although we probably will if the lamp is installed where nobody can do the cleaning without great difficulty or hazard. The modern industrial lighting unit costs too much for merely temporary results, and it is too good a piece of apparatus to be wasted.

It is reasonable, therefore, to add enough to the installation to make it work, and to enable it to give the continuous results of which it is capable.

President, ALLISON J. THOMPSON.
The Thompson Electric Co.,
Cleveland, Ohio.



Mechanical Maintenance of Power Drives

This department will furnish mechanical details of installation, operation and maintenance of equipment in the path of power service from the first mechanical driving element through transmitting equipment to all driven machines.

How to Make a Motor-Driven Crushing Device

BREAKING up old annealing kiln pots was a hard and troublesome job until we constructed the pot crusher which is shown in the illustration. This device has worked so satisfactorily that a description of it may be of interest to readers of INDUSTRIAL ENGINEER who may have use for a machine which will exert a heavy crushing pressure.

As will be seen, the crusher consists essentially of a shaft threaded for a distance of 2½ ft. with a worm screw which passes through a heavy, threaded bearing and is driven forward or backward by a motor through a gear which is keyed to the shaft so that it will turn the latter but allow it to move endwise. Two parallel 8-in. I-beams, 8 ft. long, form the base of the crusher.

The shaft is 6½ ft. long and has cut in it a worm screw of four teeth to the inch for a distance of 2½ ft. at the forward end. The screw portion of the shaft is 2¾ in. in diameter. The remaining 4 ft. of the shaft is 2 7/16 in. in diameter and is smooth. A long keyway ⅝ in. wide and ¼ in. deep is cut in the end of the shaft. A key in the large gear, which is 26 in. in diameter and has 104 teeth, fits loosely enough in the keyway to allow endwise movement of the shaft. The forward end of the shaft is fitted with a hard steel pin 1¼ in. square which is set about 2 in. into the shaft. The forward bearing is 8 in. square and carries a brass sleeve 1 in. thick through which the worm screw on the shaft threads. The rear bearing for the shaft is, of course, plain. Two long 1-in. rods tie the bearings together and serve to equalize the stress on the front bearing.

The shaft is driven by a 15-hp., 60-cycle, three-phase, 1,165-r.p.m., slip-ring General Electric motor whose shaft carries a 3½-in. pinion with fourteen teeth. The motor is mounted at one side of the shaft on two short lengths of channel iron bolted across the I-beam support. With this outfit, we use a General Electric reversible controller, type CR3203, T133B with a type CR3223 resistor.

At full speed, the worm screw advances at the rate of 1 ft. in 18 seconds, and gives enough power to crush in one side of a pot and crack it into two pieces which are then thrown back into the furnace and remelted. These pots are 22 in. square, 12 in. high and 1 in. thick. On cold days this machine will crack the iron pots as fast as two men can handle them, but in warm weather the pots will bend a long way before they will break.

New Britain, Conn. H. S. RICH.

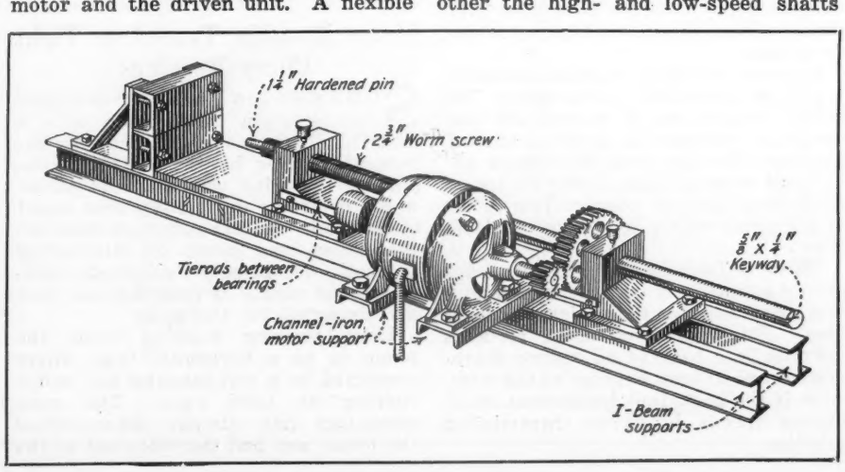
Details of a motor-driven crusher in which the force is applied through a long worm screw.

Construction and Operation of Spur Gear Speed Reducers

SPUR gear speed reducers are totally-enclosed spur-gear drives designed to decrease or step down speeds between electric motors and comparatively slow moving machines. In application they are interposed between the motor and the driven unit. A flexible coupling connects the motor shaft to the high-speed reducer shaft, which is thus driven directly at the motor speed of revolution. Another flexible coupling connects the low-speed shaft of the reducer to the shaft of the driven machine, causing rotation at a relatively low speed. The final speed of the driven machine is governed by the revolutions per minute of the motor, and by the reduction ratio accomplished by the reducer.

Spur gear reducers are most generally made in reduction ratios ranging from 4 to 1 up to 200 to 1, although there are many cases in which smaller or larger ratios are required. Spur gear reducers consist essentially of one or more trains of spur gears assembled in a housing, with provision for oil bath lubrication. They are manufactured in a wide range of standard sizes, horsepower capacities and ratios. The ratio of reduction when once selected is constant; so in this connection they should not be confused with a change-speed box or variable-speed transmission.

The speed reducers fall into two general types so far as internal design is concerned. In one type the high- and low-speed ends are concentric, thus making a straight-line drive. In the other the high- and low-speed shafts



are not concentric, giving an offset drive. Each style has certain advantages of its own, while many general advantages are common to both. As an example, space conservation in one instance might call for the concentric type, while under different installation conditions the offset type might be found more suitable for the location and as a space saver.

Offset reducers are designed with one or more trains of spur gears assembled in a cast-iron housing in which the housing is split horizontally on the center line of the shaft. The shafts are thus all in the same horizontal plane. The gear assembly is somewhat similar in arrangement to an ordinary open, spur-gear drive.

Inasmuch as each pinion and gear is required to carry the full load at the point of contact where each gear engages, the pitch diameter and face of the gears must be proportioned with this in mind. That is, the gears must be larger and the pitch line velocity greater than if the load were distributed between two or more sets of gears.

The straight-line or concentric drive is entirely different. It consists of one or more trains of spur gears having several points of contact where each train engages. This is done by surrounding a central driving pinion by two, three or more gears equally spaced, the central pinion driving each of the surrounding gears, thus providing separate points of contact for each train.

The assembly is made in a cast-iron housing of circular section with removable heads. The high- and low-speed ends are concentric, and have the same direction of rotation. Due to the total load being distributed among several points of contact, the gears may be designed with a finer pitch, with smaller pitch diameters and consequently with lower peripheral velocities than when single-point contact is used. Also, small gears lend themselves to better accuracy and in manufacturing can be held commercially to closer limits.

Spur gear speed reducers of the types under discussion have been manufactured for about 20 years and probably owe their early popularity if not their actual existence to the cement industry. The atmospheric conditions in cement mills are such that exposed or open gear drives quickly deteriorate, due to the destructive action of the cement dust. The advantages of the enclosed speed reducer apply to other industries even though atmospheric conditions are not so serious.

Economy of space in many instances is also an important consideration. The safety feature, due to its enclosed construction, reduces the accident hazard. Further, the fact that the gears are running in an oil bath, under dustproof conditions, insures positive lubrication at all times with a minimum of attention.

This self-lubrication feature has proved particularly important in obtaining acceptance for the enclosed reducer idea. Totally-enclosed speed reducers running in a bath of oil reduce depreciation and upkeep expense to the minimum in the important department of reducing speeds in power transmission practice.

Since reducers with motors do away to a large extent with pulleys and belts and other space-consuming devices, they do not interfere with the diffusion of light, and help to make the factory more attractive.

The question of initial cost is, of course, an important factor in almost any sale. Although the cost of installing speed reducers varies, it can be said that they are not more expensive than other methods of obtaining reduced speeds when the jobs as installed and ready for operation are compared. It is true that the cost of various units such as gears, belts, ropes and shafting may be lower, but the cost of laying out, assembling, installing and adjusting these various units must be considered. The enclosed reducer has a big advantage in upkeep cost. As the motor and reducer are mounted on a single base and connected to the final drive by a flexible coupling, alignment and bearing troubles are done away with.

A few of the more common applications of speed reducers are on elevators, conveyors, feeders, agitators, mixers, cookers, screens, stokers, tables, fans, dryers, crushers, car hauls, pumps, hoists and gas producers.

Mechanical Engineer, WARREN G. JONES.
W. A. Jones Foundry & Machine Co.,
Chicago, Ill.

Bearing Cost Decreased by Using Steel Pipe in Place of Cast Shell

MANY motors, in particular the railway motor type 12-A and 47-D, use a cast-steel shell. It has been found that a saving of more than $1 per bearing on new bearings for the railway-type motors may be realized by using steel pipe for the shell instead of a steel casting.

It was found that steel castings for bearing shells for the 12-A and 47-D motors cost about $240 per hundred. The cost of 4½-in., XX steel pipe and its cutting runs about $136 for the same number of bearings.

A further saving can be made in the machine work on the steel pipe bearing, for the pipe may be worked faster than the steel castings, which may have sand and hard spots in the surface.

Electrical Engineer. D. W. BLAKESLEE.
Jones & Laughlin Steel Corp.,
Pittsburgh, Pa.

Motor Trouble Traced to Tight Pump Bearings

SOME time ago I was sent to a mine to ascertain the trouble with a centrifugal pump motor. The only information given by the master mechanic at the mine was that the motor would not come up to its proper speed under load. He did not state whether the motor was direct or alternating current. Accordingly I collected a miscellaneous supply of material and tools and departed for the mine.

Upon arriving there I found the pump to be a horizontal type, direct connected to a self-starting a.c. motor running at 1,800 r.p.m. The mine mechanics had already disassembled the motor and had the rotor out of the stator. I carefully examined the stator for burned coils and tested it for shorts, opens and grounds. After failing to find the trouble there, I turned to the rotor which was of a type unusual in this part of the country (Alabama). The motor was manufactured by the Century Electric Company, and was a 60-hp., three-phase, 220-volt 60-cycle design. It was self-starting; that is to start it, the switch was thrown to the closed position and the motor accelerated automatically by a centrifugal arrangement commonly used on single-phase motors. The rotor had two windings. One was just a plain induction rotor winding, while the other was wound and connected to a disc commutator as in the ordinary single-phase motor. This commutator was not equipped with brushes, however, but had a fan which was screwed up on the spring and contact mechanism, acting as a nut. The fan was locked in position by a key. It also had a felt washer on the inside face to prevent oil from entering the contact receptacle.

I removed the locking key and fan, counting the number of threads in order to know just where to replace it. The shell for the centrifugal contacts was found to be broken and one piece had worked loose. This loose piece was, I judge, the direct cause of the machine not attaining speed as it probably bound the other parts of the shell or the spring. Realizing that it was best to make a sure repair, I loaded the rotor on a truck and carried it to the repair shop, where the machinists duplicated the shell. The rotor bands were resoldered, and also the commutator.

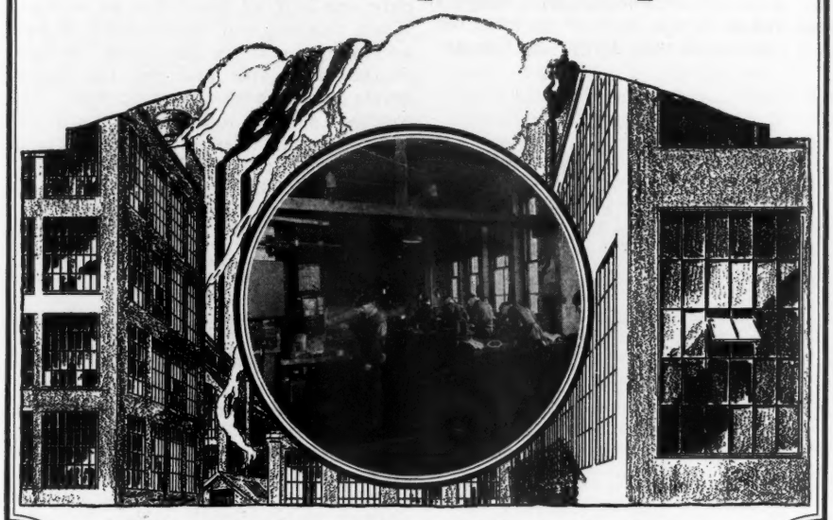
While examining the rotor in the shop it was found that one of the rods or plungers that actuated the contact mechanism, was longer than the other. The short rod had worn from some cause. This rod was heated and drawn out to equal the length of the longer rod. I believe that this short rod in closing the centrifugal switch did not exert equal pressure on the shell, thereby causing one side of the shell to move behind the other and in this way have a tendency to crush the contact shell, which was constructed of cast iron.

The rotor was returned to the pump and the motor reassembled. It ran finely without load. The coupling was bolted up and the switch thrown in, but the motor would not pick up. The adjusting nut or fan was loosened a turn or two and the motor again assembled, but it would not start. The coupling bolts were then removed so as to disconnect the motor from the pump and the motor started fine.

From this it was evident that the trouble was in the pump, which had been overhauled while the motor was down. All the bearing caps, including the thrust bearing, were loosened and the motor reconnected to the pump. It then ran nicely. It was operated against a 130-lb. pressure for 30 min. and was then shut down and examined for heating. With everything apparently all right the motor was started several times with the load, in order to be sure it was O. K.

Birmingham, Ala. GRADY H. EMERSON.

In the Repair Shop



This section is devoted to repair work, large and small. Special attention is given to shop or bench tools and short cuts or improved methods. Contributions are always welcome.

Working Out a Change in Winding of an Induction Motor

THE following details describe a change made in an induction motor that was brought in for repairs and indicates how a live coil man can save considerable time and money by taking all points into consideration when repairing motors.

The job in question was a 50-hp., 850-r.p.m., 220-volt, 60-cycle, three-phase, squirrel-cage induction motor, used to drive a ventilating fan in a large factory. The application required that the motor operate at its full rated load, 18 hr. a day. The air passing the motor was from a drying room, which kept the motor quite hot. The job was a day-and-night proposition, and the customer asked us to give it all the copper we could.

The winding data was 72 slots and coils; the coils were 2-layer, diamond-mould wound, each coil consisting of eight turns of three No. 17 d.c.c. wires in parallel with a formation of three wide by three deep. This was an old type of coil that was composed of three single coils; that is 216 single coils of eight turns of one No. 17 wire were wound to shape on a mould and these three coils were assembled to make one complete coil. The pitch was 1-and-9, and the coils were connected 4-parallel star, for 220 volts.

We first decided to make the coil a puller type, that is, wound on a shuttle complete and then pulled to shape. It was next decided to try to use a ribbon wire instead of three No. 17 wires. On consulting a wire table it was found that No. 17 wire has a bare diameter of 0.0453 in. So that the size ribbon required would be 0.0453 by $(3 \times 0.0453) = 0.0453$ by 0.1359 in. One No. 17 wire has an area of 2,048 circ. mil, and three an area of $3 \times 2,048 = 6,144$ circ. mil. On consulting a ribbon wire table we found an 0.0453 in. by 0.145 in. bare ribbon, with an area of 7,804 circ. mil. The increase in cross sectional area was due to less cotton and the filling in the space between circles with copper. We then could make a coil with eight turns of one 0.453 in. by 0.145 in. d.c.c ribbon, but we decided to check further to see if the turns per coil could be reduced to four, using a 2-parallel star connection, which would give the same turns per phase as an 8-turn coil and a 4-parallel connection.

By using four turns this would mean a conductor of twice the cross section, or 0.0906 in. by 0.145 in. On looking in the ribbon wire table, we found an 0.092 in. by 0.145 in. ribbon wire with an area of 16,972 circ. mil. Checking the insulated sizes, No. 17 d.c.c. wire has an insulated diameter of 0.054 in.; then the room taken up in the slot, width-wise, by three No. 17 d.c.c. wires would be $3 \times 0.054 = 0.162$ in., and two No. 17 d.c.c. equal 2×0.054 or 0.108 in. The insulated size of the 0.092 in. by 0.154 in. d.c.c. ribbon wire would be 0.109 in. by 0.167 in., which is close enough to the 2 by 3, No. 17 d.c.c. wire size. By replacing six No. 17 wires with one ribbon wire the circ. mil area had been increased from $6 \times 2,048 = 12,288$ circ. mil to 16,972 circ. mil, or an increase of 38 per cent in copper. Also this made a better coil from a mechanical standpoint and reduced the turns from eight to four, reducing by more than one-half the time required to wind the coils.

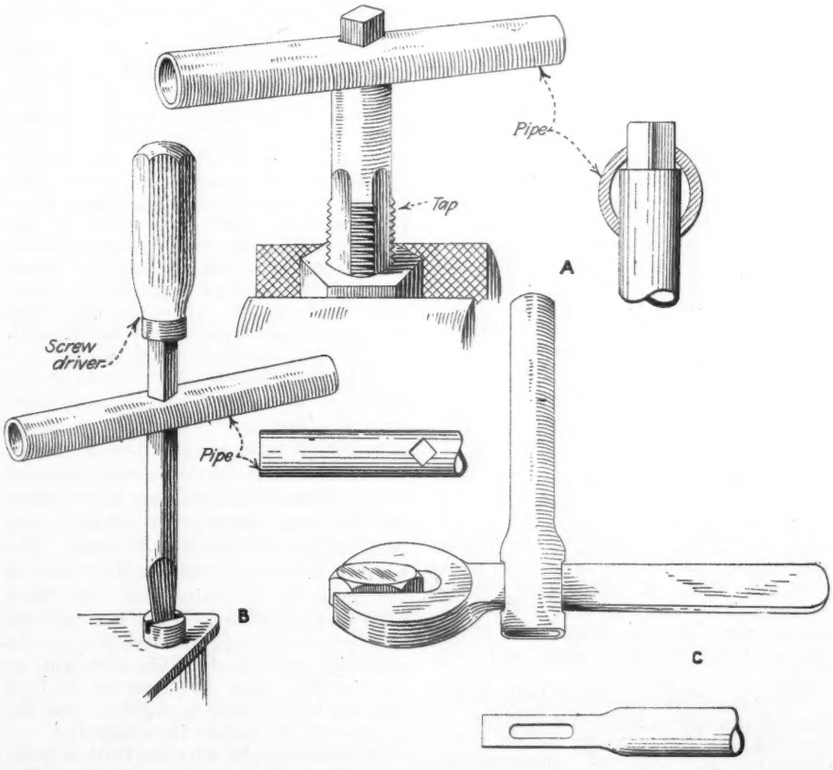
From the above it follows that it pays to investigate each job from A to Z for time-saving and improvement factors.

Wilkinsburg, Pa. A. C. ROE.

Simple Devices That Are Handy as Wrench and Tool Handles

IN SHOP work wrenches and handles to serve specific purposes are not always available. The monkey wrench is invariably called into use to help out in turning some tools. However, this is not a handy tool to use in conjunction with other tools. Several con-

Three types of wrench and tool handles that help out in tight places.



venient devices that are handy for such uses are shown in the accompanying illustration.

The first of these, (A), is a wrench for a reamer or taps, that is made up from wrought-iron pipe. This is readily made, holds the tap or reamer squarely and affords good working grips.

The second tool, (B), is a handle for the usual square type of screwdriver, and is useful in the removal or setting up of tight machine screws. The handle is a short length of pipe, squared out for the blade of the tool, as shown.

The third tool, (C), is an auxiliary handle for an open-end wrench, and is similarly made from pipe. The end is flattened and slotted to slide over the wrench handle, as shown. With this extra handle, the user works to an advantage in that both hands are used on the tool, when the bolt resists turning with the usual handle of the open-end wrench.

Washington, D. C. G. A. LUERS.

How a 750-Hp. Motor Was Banded Under Difficulty

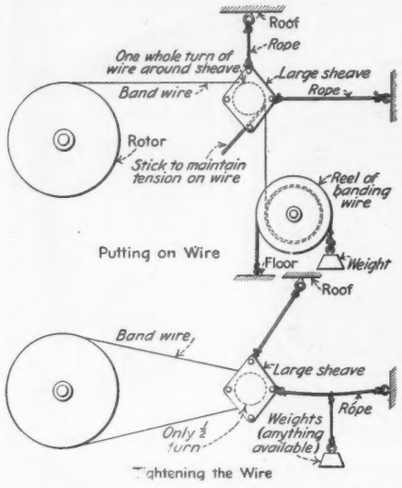
ONE of the hardest jobs I was ever called upon to do was banding the rotor of a motor driving a 20-in. centrifugal pump on a suction dredger. This was a 750-hp., wound-rotor 2200-volt, three-phase, 350-r.p.m. motor and was direct connected to the pump by means of a flexible coupling. In order to make clear the difficulty under which we worked it may be well to explain that the motor base was on 12-in. channel iron which was used for bracing the flat bottom of the steel hull of the dredger. A steel beam 4 ft. high and also used for bracing ran from fore to aft through the center of the dredger. The operating platform was about 4 ft. higher than the shaft of the motor and was cut out around the motor to allow the operator room.

When rotor trouble developed, it was necessary to tear out about 2 ft. of the operator's platform. The stator was jacked over as far as it would go or until it struck the beam running fore and aft and the rotor was pulled out until it was 8 in. from the remaining part of the platform, or just enough to allow arm room for a man to handle a heavy soldering iron, which was best heated in a forge on the job.

The rotor was then slightly more than half-way out of the stator frame, with blocking at one end holding up the rotor in the stator. Two blocks with semi-circular slots slightly larger than the rotor shaft, and well greased, served as bearings for the rotor during the progress of the work. These bearing blocks were placed in position during the final reblocking, so as to allow for proper clearance of the rotor as it was rotated in the frame. The blocking was well braced, to avoid any possibility of upsetting due to rocking of the dredger, and to maintain the proper clearance against the eccentric pull of the band wire and rope drive.

When all of the electrical trouble was cleared up, there came the problem of banding this rotor which was 7 ft. in diameter, and this was accomplished as shown in the illustration.

A 2-in. hawser was given a full turn around the winch of the dredger, spliced with a long splice to make it continuous, then passed around the rotor. Another large sheave with weights attached to it was used as an idler for this improvised rope drive. By this arrangement we were able to use the winch for turning the rotor while the band wire was put on.



The band wire was first put under light tension and then tightened.

After the desired width of band was obtained, the wire was cut, given one-half turn around the sheave wheel and the loose end fastened to the rotor. By turning the rotor in the opposite direction, the band was rewound to one side of its original position and by hanging a weight on the rope attached to the side of the sheave, the tension of the wire was increased while it was being rewound. The rotor was again turned in the opposite direction (this time in the original direction), the tension further increased by hanging more weight on the rope and the band rewound to the desired position under heavy tension.

The banding wire was put on as shown in the upper portion of the illustration. Another large sheave was fastened in the position shown. A complete turn of banding wire was put around the 2 ft. wheel of the sheave and the end fastened to the rotor. The housing of the sheave is separated from the wheel by four pins. One of the helpers held a hardwood stick against one of the pins and against the wheel and thus maintained a fairly good tension on the wire when it was first wound on, as far as was possible with the rotor in its first position.

The rigging was then changed as shown in the lower part of the illustration. The band wire was cut, given a one-half turn around the wheel of the sheave and the loose end fastened on the rotor. Weights were then placed on the rope holding the sheave, thus putting the wire under tension. The winch was reversed, driving the rotor in the opposite direction and the band wire wound tighter. When the end was reached, more weights were put on the rope and the winch again reversed, or run in the same direction as at first and the wire wound as tight as was desired, and the bands then soldered.

By winding the wire on in this manner the slack was automatically taken up and we could have put the wire under sufficient tension to pull it in two, if we had so desired.

It was possible, of course, to band only one-half of the rotor at a time. When this one end was finished, it was necessary to shove the rotor through to the other side and put the stator frame back where the rotor was. Altogether it was a long and hard job but by the exercise of a little ingenuity, we were able to do it satisfactorily under conditions which seemed at first sight to be almost hopeless.

Oakland, Calif. S. H. SAMUELS

An Emergency Repair That Insured Protection Against Field Breakdowns

THE writer has had occasion several times to repair or put into operation a Type C direct-current, Westinghouse automatic planer control used on a Betts planer. This installation was one of those wartime "temporary installations" which has not been changed to permanent. It is, however, wired correctly and gives good service with very few interruptions—but when there is an interruption it calls for a "good hunting" expedition.

One of the worst service interruptions on this installation was caused by a spark jumping from a shunt field lead to the series field lead, which is uninsulated. The shunt field lead had a very small rupture in its insulation, and this worn place was in the top of the motor, so that the spark could not well be observed and was not noticed at the time of the trouble.

The sparking occurred at the reversal of the motor after the planer had made a cut and was about to return, when the load was heavy, likewise the current. This induced the high voltage required for the jump spark. The other effects were to slow down the motor on return and cause a slight arc at the brushes momentarily, with a severe arc across the butterfly reversing contacts. When this latter arc was blown out by a puff of air, the motor would speed up, and as all connections checked with the blueprint, and it was rather late at night when I had made all tests possible with the instruments available, I decided to place a shunt magnet coil wound for 230 volts direct current directly above the butterfiy contacts to blow out the arc formed at the reversal of the motor. This magnet was so wired that it would be in circuit when the operating circuit was closed.

The main thing was to get the planer to operating satisfactorily and this was accordingly done. I would like to state that the scheme worked admirably. This installation has given very little trouble since this change was made.

Later a very careful inspection on overhauling revealed the small break in the insulation on the shunt field lead which I believe was the cause of the trouble, but the blow-out coil has not been removed and probably never will be, as it will answer as an additional protection in the future.

Birmingham, Ala. GRADY H. EMERSON.

How to Change Direction of Winding Armature Without Changing Rotation

MANY small armatures are wound by machine so that the armature is turned end-for-end in a right-hand direction while the wire is guided in the slot as the armature revolves. The wire is really wound on in a left-hand direction. We do not use a machine for winding small armatures in our shop but do them all by hand, holding them in the left hand and winding the wire on with the right hand. Many winders find it easier to put the wire on in a clockwise direction and so they do it that way, even though it was originally wound counter-clockwise, but when the motor is assembled the armature runs in the wrong direction. To those who have experienced this trouble, let me say that when you change the direction of winding, you should also change the direction of the progression of the winding.

For example, assume that an armature is wound left-hand or counter-clockwise with the winding progressing from slot to slot in a right-hand direction. If desired, this armature may be wound right-handed with the winding progressing to the left. If it is wound left-hand, progressing to the left, change it to right-hand, progressing to the right. It is only natural to suppose that if the winder is a man who uses his left hand to wind the wire on, the above rules will work vice versa.

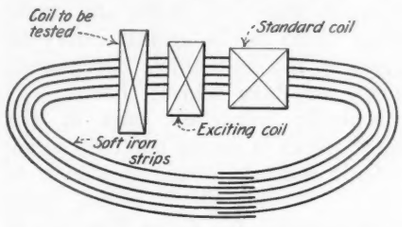
Darby, Pa. GEORGE WM. HANLON.

How to Determine The Number of Turns in a Coil Without Opening It

WHEN doing repair or experimental work on electrical apparatus, it very often happens that a duplicate of a certain coil is wanted without opening or destroying the sample coil. The question then comes up as to how many turns are on the coil and what size of wire was used in winding it. Of course, nearly all coils wound in factories have a code number on them so that one need only send in the code number of the coil to obtain the new one from the manufacturer. However, it often happens that the duplicate coil must be had immediately, or that the code number has been lost, so that no identification of the coil is possible. In this case, about the only thing for the average electrician to do is to tear the sample coil to pieces and see what is in it.

If a coil with a known number of turns can be obtained, that is approximately like the coil with the unknown number of turns, it is possible by a simple test to determine the number of turns in the sample coil. Recently I had just such a case to deal with in a coil used on a lifting magnet. I was told how many turns were in the old coil which was still good and which I wished to save for further use. When I had completed the new coil, it did not lift as much as the old one. I tested it as described below and discovered that the old coil had about fifty turns less than it was thought to have. I therefore took off fifty turns from the new coil, after which it worked the same as the old one.

In the accompanying diagram is shown the arrangement of the magnetic circuit by means of which the two coils were compared. Soft sheet iron strips are passed through the centers of the standard coil (which is wound with a known number of turns), the coil to be tested (wound with an unknown number of turns) and an exciting coil, which is to furnish the magnetic flux for the circuit. The exciting coil can be almost any kind of a coil that will fit over the soft iron strips. It must be placed in the center of the magnetic circuit as shown in the diagram and is excited with alternating current. Care should be taken not to over-excite or saturate the iron, so as to keep down the magnetic leakage. The ends of the soft iron strips should be clamped together after being passed through the coil, so as to reduce the reluctance of the magnetic circuit as much as possible.



The voltage induced by the sample coil is compared with that induced by a coil with a known number of turns when both are placed in the same magnetic circuit, which is excited by an exciting coil.

Knowing the number of turns in the standard coil and the induced voltages in both coils, the number of turns in the coil under test may be calculated by means of the formula given in the text.

The two coils that are to be compared are placed one on each side of the exciting coil as shown in the diagram, with the center of each coil at the same distance from the exciting coil. If both coils are alike, they should be placed as near to the exciting coil as possible but if one is wider than the other, a little allowance should be made as shown in the diagram, which shows such a condition. The voltage induced in the standard coil and in the coil under test is measured with a voltmeter while the exciting coil is furnishing the flux to excite the two coils. The number of turns of the coil under test may be determined by means of the following formula:

$$N1 \div N2 = E1 \div E2,$$

where

N1 = number of turns on standard coil,
N2 = number of turns on coil under test,
E1 = voltage across standard coil, and
E2 = voltage across coil under test.

After the number of turns on a coil are known it is a simple matter to estimate the length of wire on the coil and if the resistance of the coil can be measured, it is very easy to figure the size of wire.

In making such a test, a little care should be taken, especially if the two coils are not alike in size or shape, because magnetic leakage may affect the result. That is, if one coil is thin while the other is a thick coil, the center of each must be in the same relative position on the core; otherwise the diameter or shape of the coils need not be alike. In fact, the size of the coil, or the size of the wire in the coil, make little difference as long as the same number of lines of force or magnetic flux pass through both the standard coil and the coil with the unknown number of turns. It is important therefore, to properly arrange the magnetic circuit so as to get an equal amount of flux through each coil. To check the result, the tests should be repeated after interchanging the positions of the standard coil and the coil with the unknown number of turns.

PHILLIP G. BERNHOLZ.
East Orange, N. J.

Making Patterns and Molds From Plaster of Paris

OCCASIONALLY it is desired to mold small parts in lead, brass, or cast iron and it may be necessary to make up a pattern or mold quickly with the equipment and materials available. For such use serviceable patterns and molds can be made from plaster of paris, as this material hardens rapidly and dries out readily. If desired, the hardening can be delayed somewhat by the addition of a small quantity of vinegar when mixing up the plaster.

When preparing the plaster care should be taken to mix it thoroughly, preferably by hand, to insure that all lumps are broken up.

If the broken part or a spare is available a mold can be made by placing the part on a smooth, flat board or iron plate, and enclosing it in a tight box or frame open at the top. The part, as well as the box, should be well greased or oiled to keep the plaster from sticking. As soon as the plaster has set, the frame should be taken apart and the pattern removed from the mold. It is advisable to allow the latter to dry overnight in a warm place and it should be washed with graphite wash or other refractory material before pouring the casting.

If a plaster pattern is used it should be kept from sticking to the mold or absorbing moisture by coating it with paraffine wax, either by dipping it in melted paraffine or applying this with a brush. Paraffine can also be used to keep the halves of a two-part flask from sticking together.

When making either patterns or molds, thin wire and nails are desirable as reinforcing material in the plaster. If it is desired to increase the bulk of the plaster of paris, thus avoiding extra expense, clean, sharp building sand may be stirred into it before pouring.

Washington, D. C. G. A. LUERS.

Reducing Accidents and Breakdowns

(Continued from page 122)

of course, was immediately covered. It is just one example of the unanticipated accidents against which we must always be on our guard.

In promoting safety work, we have adopted the committee form of safety organization. Safety pays according to the increased number who become interested in it and adopt it, and also because of having served on a committee a larger number of men, who are intimately connected with the plant and its activities, are making suggestions and pointing out new hazards and how they may be overcome. This organization consists of one safety director or engineer, who devotes his whole time to safety and personnel work and four different committees, each meeting monthly on consecutive Thursdays.

The first meeting is made up of a committee of the men chosen by the men themselves; the second consists of foremen; the third is made up of men appointed from the various departments by their foremen; the fourth committee consists of the three general foremen and three others. The safety director acts as secretary of these committees, records suggestions and recommendations, investigates between meetings and reports on them to the next committee. Action is reported back to the committees instigating and passing on the idea. This secretary keeps a record of each action of any of these committees until its adoption or rejection.

This does not mean that every suggestion takes four weeks to be acted upon. Small matters are handled quickly by reporting them directly to the mechanical department which carries them out and reports back. Items which will probably cost over $25, must, however, bear the approval of the superintendent. Emergencies are also handled without going through committee routine. It must be understood that the purpose of these committees is to bring out more ideas and add to the interest of the men. This cannot be obtained without letting them see results. Not all suggestions, however, are used as adopted, because many of them are crude ideas which can be greatly improved upon by the mechanical department when they take hold of them.

Another important part of the safety work is giving publicity to accidents and hazardous conditions, especially those which result from carelessness. We found that one of the best ways of getting this over to the men was by means of bulletins made from photographs of the hazardous condition or especially posed to show how the accident happened. This is not as easy as it may seem because a great amount of care and diplomacy must be exercised to prevent getting the ill-will and opposition, instead of the respect and co-operation, of the men. For this reason we do not mention who was responsible for the condition photographed and, if it was especially posed, we give the man in the picture credit for knowing better so that he will not be "kidded" by the others. Four of these bulletins are reproduced on page 120 as we used them. The text accompanying each illustration is set in our print shop.

On one occasion an outside millwright gang which was doing some construction and installation work on contract gave us an opportunity to take a number of photographs which showed carelessness, but did not reflect on our own men, although it caused them to be more careful. One of these pictures showed an opening cut through the floor in a passageway and left overnight unguarded by barriers or signs while the gang was away. Another showed boards with nails left lying around. Still another was of an accident which resulted from men carrying a long pipe and leaning one end against a roll of paper standing on end. The roll tipped and broke a man's leg. Other pictures showed men carrying tools and even a mop and pail up a belt man-elevator which we have installed to carry the supervisory force between floors. Incidentally, one of the safety suggestions brought out the need of an automatic stop to prevent anyone riding past the top floor and being dumped over the top.

The camera, however, is not used as much now as at first because we do not find as much to photograph. These photographs make excellent bulletins as they are right at home and impress upon all the cause and effect of an accident which most of them have heard of and know the principals.

In promoting the safety work considerable attention was given to interesting the mechanical and electrical men responsible for the maintenance and operation of the equipment, because much of the success or failure of safety education depends upon the example and attitude of these men. The general foremen in charge of these men were very enthusiastic in their co-operation. One of the rules made was that the men should clean up after every job. While this is good housekeeping it helped in safety by promoting pride in the work and feelings of thoughtfulness and carefulness. Poor housekeeping destroys pride and also makes many accidents possible.

Altogether we are quite well satisfied with the progress of our safety work, but must keep continually at it to see that the interest of the men is sustained. Safety work cannot stand still; it must progress or interest will lag and accidents increase.

Starting equipment and panel boards for four flaking rolls and the compensator for two groups of motors.

Since only one motor of a group is to be started at a time, a single G. E. CR-1034, Type NR compensator is connected to the line for each two groups of motors and their panel board. A G. E. barrel switch with the compensator coils removed and overload relay mounted in their place is used for the actual starting. This not only affects a considerable saving in the installation cost, but it permits of starting the machines in any sequence. The only restriction is that only one mill in a group can be started at a time.

Requirements of Safety Switches

(*Continued from page 126*)

(9) The door should be locked when the switch is in the closed position, but it should be possible to unlatch the door by means of a screwdriver for inspection. It should not be possible to throw the switch in until the cover is closed and latched.

(10) The door of the switchbox should, when open, expose the interior of the box completely, permitting ready inspection and access to both line and motor leads for convenience in testing.

The open type of distribution switch panel with busbars, fuses and switches mounted on the face of a marble or slate panel has long been a source of danger and trouble. The fuses were usually on the circuit- or the line-side of the switch. Tools would often fall onto the bus mounted on the lower part of the panel and danger accompanied the handling of large fuses while live. From the standpoint of design of a distribution system this panel represented a very inflexible unit because the bus could not be reinforced and additional circuits could not be added when the load increased unexpectedly, as is usually the case in a growing industrial plant. During 1918 in view of the success attending the use of safety switches for motor drives, the writer installed the type of distribution panel shown in Fig. 3 in which use is made of a pipe rack with busbars running along the top of the rack and supported on pipe-mounted bus insulators. Details of a typical panel are shown in Fig. 2. Standard enclosed safety switches of 400- and 600-amp. capacity were mounted on panels supported on the pipe framework. The circuits were divided, the number of circuits being determined by two requirements; first, the metering necessary and, second, that no circuit should be loaded beyond the capacity of a 600-amp. switch. This follows because above 600-amp. fuses must be installed in multiple, and multiple fuses are altogether incompatible with continuity of service. Whenever the load increases a 600-amp. switch may be substituted for a 400-amp. switch, or where a 600-amp. switch is already installed a section of bus may be put in with a new circuit to provide for the additional load. As for the additional cost of the construction, this switchrack is about double the cost of the old panel itself. The remainder of the wiring cost remains the same. The additional cost is, however, a very small percentage of the total wiring cost. The switches are protected from dust by the enclosing box and when high humidity conditions are encountered the distribution structure should be enclosed in a fireproof housing which will practically eliminate condensed moisture and attending corrosion. Metering may be easily accomplished by using switchboard-type current transformers mounted in the leads between the bus and the switches, or a bus-type transformer may be inserted at the feed end of the bus to meter the entire distribution center, if it supplies a single department.

Reminiscences of a Trouble Shooter

(*Continued from page 132*)

"Right now there comes the recollection of another trip, an inspection trip to repair waterwheel generators, large in capacity and size. A little 'shrimp' met me at the station, and took me to his home for lunch, where a predominant and varnished wife dictated to her lord and master a few things that make men go to war for peace. In using the word 'varnished' I mean to imply the kind that is 'dear this' and 'honey that,' while at the same time probably stepping on his toes or kicking him under the table to get an answer in accordance with her wishes. This ordeal completed, we adjourned to the station. It was a magnificent place with modern machinery, and was a fine monument to some engineer. The machines were polished and clean, the switchboard in good condition, brass all shined up and, in general, the place presented a very good appearance. This station had been in continuous operation for about ten years and it was desired to show that the manufacturer should pay a proportionate part of a general repair expense.

"An inspection of the main generators was sufficient to tell the inspector a whole volume. Coils were actually clogged with dirt at points where a hurried cleaning at a date not very long preceding my visit had reached the surface dirt, but not the dirt that a competent man can find. Furthermore, this dirt was of a pure oil nature, the source of which was leaky oil pipes and bearings at every possible point that oil could get out. The bearings were 'shot'; some had clearances that made one feel in danger, knowing what consequences might result. The lower bearing of lignum vitae was in such bad shape on one of the wheels that the runners touched the casing at every revolution, imparting a decided shock to the entire machine. The oil in all the bearings was in poor condition, although the chief said it was changed often enough to insure good oil. His trouble was in his filter system, which was so dirty that good oil would come out contaminated. His switchboard looked good, but some of his meters were out of commission, although the company had a meter department. One of his current transformers was in commission with the meter removed and the secondary open. His Tirrell regulator was erratic, but a hundred or more fish flies in the oil chamber will make anything erratic.

"Behind the scenes in this inspection we found the chief at a fine desk so cluttered up with everything that the insides were hardly visible. He had been with the company three or four years. He had seven operators with a four-hour shift himself in operating. None of the operators had been with the company two years, while most of them had their first year to complete. Notices on the board assigning work were written in longhand by the chief and many misspelled words were apparent. Unfortunately, another notice on the board, from the superintendent, stated that the machines had to be cleaned up at a date just prior to my visit. A talk with the operators disclosed that trouble with men was a continuous thing, since the chief was ignorant of his work and more ignorant of his men. One faction was always led by the chief while the other faction was led by—well, let us call them the other side.

"It is regrettable that good machinery should be put in the care of such men, ignorant of themselves, of others, of their profession, possibly underpaid and merely holding their jobs. Think of the ultimate cost of these men! To go on with further details is needless. There is only one kind of a report to make under these conditions. It is, however, in order to remark (and I wish this remark would bore a deep hole into the consciences of those who need it) that the inspecting engineer bases his report on a great many conditions aside from those he finds in the ma-

chinery. Contributory elements either credit or discredit what he finds in a plant, based on his engineering ability and a good understanding of what to look for and where to find the little details that tell a whole story to him.

"That little squeak that the operator is used to, that little oil leak that does no apparent harm, the kind of housekeeping, the types of men employed, their loyalty and knowledge of themselves, the company and their work, are factors that tell an operating story in themselves.

"And, now I want to say something else," Ed went on, "that you can pass on to the readers of INDUSTRIAL ENGINEER. Good or bad operating conditions in men or machines cannot be effected over night; when conditions are good, you may be sure that they are the results of eternal vigilance by loyal workers who know their work and take pride in doing it to the best of their ability. Such interest and work are reflected within and without in the machinery, and in the earnings that make a plant a paying proposition and a place of engineering beauty, alike, to the experienced and the inexperienced visitor.

"Just ask your readers for me if their plants will stand an inspection tomorrow."

Practical Books

For Your Personal Library

Every man who aspires to larger responsibilities should build up a professional library. Copies of these books may be obtained from the publishers mentioned.

Practical Calculus for Home Study—By Claude Irwin Palmer. Published by McGraw-Hill Book Co., 370 Seventh Ave., New York City, 435 pages, $3.

This book is prepared for those men without college training who desire a working knowledge of the calculus and its practical applications. For those who have a groundwork in algebra this book provides a means of understanding and making use of calculus in design work.

* * * *

Natural Gas—By Lester Clyde Lichty. Published by John Wiley & Sons, New York City, 516 pages, $7.50.

This book deals with the measurement, compression and transmission of natural gas and presents various technical formulas and details of equipment employed. In many cases examples have been worked out illustrating the use of various formulas and charts as a guide in solving a variety of problems encountered in the use of natural gas.

* * * *

Elements of Electrical Engineering—By George D. Shepardson. Published by The Macmillan Co., New York City, 326 pages, illustrated, price $4.

In the preface of this book the author states that it was written as a textbook on electrical engineering for technical schools and colleges. It includes a brief discussion of fundamental and operating principles of important types of direct- and alternating-current machines. The treatment is semi-technical with sufficient illustrations to point out the practical applications of the principles discussed. The chapter headings are as follows: effects and varieties of electricity; units; the flow of current through a circuit; typical electric circuits; electro-magnetism; electromagnetic mechanisms; measurement of current and voltage; dielectric phenomena; insulation; conductor materials; wires; measurement of resistance; relations between heat and electricity; electrochemical effects; primary batteries; storage batteries; induced electromotive forces; alternating currents; electric motors; and transmission and distribution systems.

* * * *

Choosing Your Life Work—By William Rosengarten. Published by McGraw-Hill Book Company, Inc., 370 Seventh Avenue, New York City, 318 pages, price $2.50.

The object of this book is to present in plain and non-technical language a simple and effective plan whereby the individual may analyze his own capacities, aptitudes and interests, compare them with the requirements of representative occupations, and plan his career accordingly. Hundreds of occupations, trades, callings and professions are described and analyzed.

* * * *

Arc Welding and Cutting Manual—Compiled and distributed by General Electric Company, Schenectady, N. Y., 127 pages, illustrated, price $1.00.

This volume has been given the designation Y-2007 and was issued to acquaint the uninformed in a general way with the common applications of arc welding, and to provide a simple and logical method by which one may acquire a certain familiarity with the characteristics and manipulation of the electric welding arc. The volume is profusely illustrated with photographs, diagrams and charts, explanatory of the text on 8-in. by 10½-in. pages. It is divided into three parts, the first of which is devoted to general information on arc welding, the second to a training course for operators and the third gives a number of applications of arc welding. This manual should prove valuable to any operator or anyone who wishes to become an operator and do the miscellaneous work required in practically all industries and trades.

Electric Wiring—By Albert A. Schuhler. Published by McGraw-Hill Book Co., 370 Seventh Ave., New York City, 249 pages, price $2.50.

This book was written as a textbook on applied electricity for vocational and trade schools and such material has been used as will enable the reader to understand the principles involved in electrical wiring. Electrical construction details are not included. The material is divided into units corresponding to chapters in the usual book construction, dealing with the following subjects: splicing and soldering conductors; bell wiring; annunciator wiring; burglar alarm wiring; electric light wiring; house wiring plans; telegraph wiring; telephone wiring and testing. Numerous diagrams are used to illustrate the principles that are discussed.

* * * *

Storage Batteries—By George Wood Vinal. Published by John Wiley & Sons, Inc., New York City, 394 pages, price $4.50.

This book presents a rather technical discussion on the construction and principles of operation of the storage battery. Under the heading of "Operation," methods of charging and details of charging equipment are taken up. A section is devoted to operating conditions, cost of operation and sources of trouble. A chapter is also devoted to testing storage batteries and one to present-day uses of storage batteries. The author is physicist with the Bureau of Standards and states that he was encouraged to undertake preparation of the book by Dr. S. W. Stratton, formerly Director of the Bureau of Standards and by Dr. E. B. Rosa, chief physicist. It is a well-rounded discussion on storage batteries from a technical standpoint.

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Tulley's Handbook in Three Volumes—Revised and enlarged by James F. Hobart, 7th edition. Published by the McGraw-Hill Book Co., 370 Seventh Ave., New York City, 1156 pages, price $7.50.

Volume 1 is devoted to the steam plant and covers steam boilers; chimneys; furnaces and stokers; fuels; coal handling and ash disposal; chimney gas analysis; combustion control; damper regulation; steam boiler evaporation tests; economizers; superheaters; feedwater heaters; filters; traps and separators; and condensers.

Volume 2 is devoted to pumps; injectors; inspirators; gages and recording instruments; valves; fittings; appliances; reciprocating engines; steam turbines; indicators and their uses; engine safety stops; tachometers; governors; pulleys, belts and gears; power transmission.

Volume 3 is devoted to d.c. generators and motors; a.c. generators and motors; lamps; circuits; transformers; mechanical refrigeration; ice-making; elevators; meters for water, steam, air, gas and coal; air compressors; heating and ventilating; internal combustion engines; and handy reference tables.

This is the seventh edition of this handbook which for nearly 25 years has been used by thousands of power plant men in their daily work. It contains practical information and a common-sense viewpoint that makes it a very useful reference for a practical man.

Trade Literature
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

Rockbestos Products Corporation, New Haven, Conn.—A 32-page booklet entitled, "Asbestos-Covered Wires and Cables for Every Service," has a number of handsome illustrations which show some of the tests applied to the Rockbestos insulation. In addition, the various types of Rockbestos protected wire for various commercial and industrial purposes are described.

Holophane Glass Company, Inc., 342 Madison Avenue, New York City—A 20-page booklet, Bulletin 394 entitled, "Holophane Industrial Lighting," contains a number of photographs of typical installations and shows some special application in a variety of industries. The characteristics of each of the industrial lighting units are illustrated and described and light distribution curves are plotted. Items of particular interest are "before" and "after" illustrations taken in a steel mill.

General Electric Company, Schenectady, N. Y.—A 12-page illustrated and descriptive bulletin, Y-2041, entitled, "Voltage Drop Control System," takes up, among other points, a discussion of: What is voltage drop control? What extraordinary thing does it do? Can I use it in any of my work? Is it worth while for me to adopt it?

Standard Conveyor Company, North St. Paul, Minn.—Catalog 3, which is the third of a series entitled "Wherever Conveying Is Done," shows by a large number of installations some of the variety of industrial applications which can be made of Standard conveyors, pneumatic tubes, stackers and portable piling equipment.

New England Sales and Engineering Company, Worcester, Mass.—Folders describe the Notadent soft metal hammer which is made in 3-, 5- and 8-lb. weights in babbitt and 2¼-, 4- and 5½-lb. weights in bronze.

Birdsboro Steel Foundry and Machine Company, Birdsboro, Berks County, Pa.—A folder describes the Jackson belt lacer which is a special machine for lacing belts. With this a continuous wire forms a series of loops in the end of the belt. These loops in the two ends are joined by a rawhide pin which forms a hinge. The booklet also contains considerable belt and pulley data.

Crane Puller Company, 54 Lake Street, Arlington, Mass.—A folder describes the Crane wheel and gear puller which is made in four sizes to take wheels from 6 in. up to 24 in. in diameter. It is made as either a two-arm or a three-arm "crowfoot" puller. This puller has attachments which enable it to be used as an arbor press, for bending pipe and on heavy truck wheels.

W. A. Jones Foundry and Machine Company, 4430 West Roosevelt Road, Chicago, Ill.—General Catalog 30 covers the complete line of "Power Transmitting Machinery" manufactured by this company. It is divided into several sections among which are: Gears and speed reducers, which covers 214 pages; pulleys; friction clutches; power transmission equipment, which includes hangers, hanger boxes, couplings, etc.; sprocket wheels and chain belting; miscellaneous appliances, such as rope sheaves, tension carriages, mule stands, belt tighteners, elevator heads and buckets, friction wheels, etc. This catalog contains 442 pages and is of a convenient size for reference.

The Yale and Towne Manufacturing Company, Stamford, Conn.—A folder describes the new Yale ball-bearing, spur-geared chain blocks which carry the load sheave on ball bearings. These blocks are made standard in capacities from ¼ to 20 tons, and special in 32 and 40 tons capacity.

Pittsburgh Transformer Company, Pittsburgh, Pa.—Bulletin 2038 describes the Pittsburgh self-cooled, radiator-type transformer which, it is claimed, is of quite sturdy construction, although light in weight for its capacity. Bulletin 2039 describes the Pittsburgh polyphase power transformers and shows their construction by illustrations.

Adjustable Clamp Company, 216 North Jefferson Street, Chicago, Ill.—Catalog 5 describes the Jorgens adjustable steel spindle hand screw clamp. The jaws are made of maple and the steel screw spindles operate steel nuts which are arranged to swivel within a convenient limit to permit adjustment of the jaws to conform to the surface clamped. These clamps are made in a variety of sizes up to 24 in.

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.—Circular 1686 entitled "Micarta in the Central Station" describes applications of standard forms of Micarta and the method of applying on busbars, connections and in making cable joints, for barriers on circuit breakers and switches, its employment as bushings, slot wedges and cleats and other miscellaneous uses. The electrical and mechanical properties of the different grades of Micarta are also given.

Lyon Metallic Manufacturing Company, Aurora, Ill.—Bulletin 104-A shows the construction and methods of erection of this company's standard shelving, including label holders, box steps, shelving benches, shelf boxes and other equipment. Considerable space is devoted to a discussion of how to order shelving. Bulletin 108-A gives directions for erection of Lyon standard shelving, both adjustable and extensionable type.

Reeves Pulley Company, Columbus, Ind.—Folder T-3030 shows the use of steel link V-belt for use on variable speed transmissions. This is composed of hardened steel links flexibly bound with rocking pins. Leather tips on the V-belt come in contact with the sides of the cones to provide the tractive contact.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis.—Publication C-2, entitled "Industrial Time-Limit Controller," describes this equipment, which is claimed to have special advantages for use in steel mill applications.

Hubbard and Company, Pittsburgh, Pa.—Catalog 24 gives a complete listing of Hubbard pole line hardware and Pierce construction specialties. This covers complete equipment for the construction of pole lines.

General Electric Company, Schenectady, N. Y.—Bulletin No. 4891-A entitled, "CR 9006 Enameled Resistor Units," lists and describes the various units which are suitable for use in connection with railway and fire alarm signals, locomotive headlights, telephone circuits, magnets, laboratory and measuring instruments, rheostats and panels.

Standard Conveyor Company, North St. Paul, Minn.—Catalog 1 entitled, "Wherever Conveying Is Done," illustrates a large number of installations of Standard roller gravity conveyor equipment.

General Electric Company, Schenectady, N. Y.—Bulletin 45609 describes the G. E. surface air cooler and the principle of the closed system of ventilation in re-circulating the ventilating air of a turbine generator back to the machine after it has been cooled by passing over the finned surface of a cooler using water as its cooling medium.

Greene Equipment Corporation, Monadnock Block, Chicago, Ill.—A circular describes the Acme armature washing fluid which is non-combustible, non-explosive and will not injure insulation.

Century Electric Company, St. Louis, Mo.—A booklet describes and gives prices on the Century Type SC, squirrel-cage, two- and three-phase induction motors, from ⅛ to 50 hp.

General Electric Company, Schenectady, N. Y.—Bulletin 67721, Class 17, describes the automatic switching equipment for synchronous converters in mining service, describes their operation and illustrates by diagram.

Roller-Smith Company, 229 Broadway, New York, N. Y.—Bulletin 100 covers a line of portable electrical instruments for signal-system testing. Bulletin 550 describes a series of direct-current relays operating with reverse current, overload, underload, overvoltage or under-voltage. Bulletin 430 describes the Roller-Smith line of direct-current switchboard instruments, such as ammeters, voltmeters, voltammeters, shunts and multipliers.

The Reinhart Electric Motor Company, 2517 Seventy-ninth Street, Cleveland, Ohio—Bulletin 180C describes the Reinco alternating-current, ball-bearing motors which are made in frac-

tional sizes from ⅛ hp. up to 1 and also in 1½, 2, 3, 5, 7½, 10, 15, and 20 hp. capacity. Simplicity of construction and ease of assembling or dis-assembling as well as the alemite method of grease gun lubrication are among the features described.

Philadelphia Gear Works, Richmond and Tioga Streets, Philadelphia, Pa.—Catalog 13 entitled "Philadelphia Speed Reducing Unit" describes a line of worm, spur, spiral, bevel and herringbone gear speed reducers. Some of these are provided with ball or roller bearings. This catalog not only describes the construction of the unit, but also gives considerable engineering data regarding the dimensions and capacities of the various units.

Crouse-Hinds Company, Syracuse, N. Y.—Bulletin 2,058 describes the Wedgetite pipe hanger which consists of a hook and a saw-tooth edged wedge. The pipe or conduit is supported in the hook which is caught over the edge of an I-beam or channel and wedged in tightly.

Celite Product Company, 11 Broadway, N. Y.—Bulletin B-8-D describes the use of Sil-O-Cel as an insulating material for industrial furnaces and ovens. A number of sketches show how this material is to be applied.

Automatic Primer Company, 111 West Washington Street, Chicago, Ill.—This circular describes the Apeco primer for automatic starting centrifugal pumps through a cleverly arranged system of tanks and connections. This permits use of a centrifugal pump on suction lifts without mechanical contrivances for producing a vacuum and without foot valves.

Martindale Electric Company, 11709 Detroit Avenue, Cleveland, Ohio—A circular entitled "Commutator Slotter Bulletin" describes commutator slotters, undercutters and other tools for maintenance and repair work.

Buckeye Blower Company, Columbus, Ohio—Engineering Data Bulletin 133 contains complete description, capacities and other engineering information concerning all the various types of multi-blade fans produced by this company.

General Electric Company, Schenectady, N. Y.—Circular 66021 describes the single watthour meter indoor current transformer for circuits up to 4,500 volts on 25 to 60 cycles.

General Porcelain Company, Parkersburg, W. Va.—Bulletins 40 and 42 describe and price porcelain low-voltage and high-voltage insulators.

Lockwood, Greene and Company, 24 Federal Street, Boston, Mass.—A 40-page, handsomely illustrated booklet describes in detail some of the features which should be considered in planning an industrial power plant. The illustrations are of a number of industrial power plants installed by this company.

The John X. Tiffin Automatic Safety Valve Company, Detroit, Mich.—A folder describes the Tiffin automatic control safety valve which is designed for controlling numerous mechanical devices that at times of emergency require other and more efficient action than can be applied by the operators or the men in charge.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.—Folder 4531-A entitled, "Westinghouse Mica Insulation," describes the various grades of mica insulation and gives their different applications. Tables are included for reference, giving the size of sheet, the standard thickness and approximate weight per sheet of each form of insulation described in the booklet.

Allan Manufacturing and Welding Company, Buffalo, N. Y.—A folder describes the Almanc arc-welding transformers for use with alternating-current power and also arc-welding generators which are arranged to be driven by either belt, direct- or alternating-current motor or by gasoline engine.

Morse Chain Company, Ithaca, N. Y.—Publication 26-A entitled "Small Power Drives" gives, in addition to a number of applications of chain drives on motors from 1/16 to 100 hp. in industrial plants, an explanation of their operation, installation and maintenance, together with the principal advantages claimed for Morse chains in industrial works.

American Blower Company, Detroit, Mich.—Bulletin 1103 devotes 36 pages to American high-speed, double inlet fans, gives the characteristic curves, distinguishing advantages, construction features, capacity table and dimensions.

Wagner Electric Corporation, St. Louis, Mo.—Bulletin 133 entitled, "The Pow-R-full Starterless Motor," devotes several pages to the history of the induction motor, and particularly to starterless motors. Several pages are given to a technical discussion of the characteristics and other features of the starterless motor as well as to its construction with particular attention to its ventilation. Safety requirements and installation are also covered.

Groundulet Company, Newark, N. J.—A booklet entitled, "Groundits and Groundology," discusses metal conduit and pipe as conductors, the common ground conductor, and suggestions for grounding overhead a.c. service. The various types of "Groundits," special connectors for grounding, are also described in this booklet.

Harold E. Trent, 1524 Chestnut Street, Philadelphia, Pa.—Leaflets describe the Trent three-heat electric metal melting pot for continuous service, which is capable of producing temperatures up to 1,200 deg. F. Other leaflets describe the Trent automatic control system for continuous service which not only indicates the temperature but controls it, whether the heat is supplied by electricity or by gas, oil, steam, or heated air. This system is made in different sizes for various temperature requirements.

Esterline-Angus Company, Indianapolis, Ind.—Bulletin 724 entitled, "Clock Improvements," discusses changes which have been made in Esterline-Angus meter clocks with the view of making the performance better and giving better accessibility.

Leeds and Northrup Company, 4901 Stenton Avenue, Philadelphia, Pa.—Bulletin 871 entitled, "Temperature Measurements in Generators, Transformers and Cable Systems," describes the operation and construction of equipment for indicating and recording the operating temperature of electric generators, transformers and power cables and other units which may heat.

The Truscon Laboratories, Detroit, Mich.—Folders describe the Truscon Super-Por-Seal, which is a transparent damp-proofing medium for treating cement and masonry without changing the color, texture or appearance of the surface. This is claimed to protect the surface against absorption and the penetration of water carrying grit, grime and dirt in suspension which would discolor or disfigure the surface.

The Ohio Electric and Controller Company, 5900 Maurice Avenue, Cleveland, Ohio.—Bulletin 204 describes the construction and operation of alternating-current, squirrel-cage, induction motors 110 to 440 volts, single, two or three phase, 25 to 60 cycle, and direct-current motors, 32 to 250 volts, of ⅛ to ⅓ hp. Another bulletin shows a large number of applications of these motors.

Champion Electric Company, 3711-3741 Forest Park Boulevard, St. Louis, Mo.—A booklet entitled, "Champion Endurance Motors," illustrates and describes briefly structural features of some of the more important parts of the different motors. These include single-phase, 60-cycle, repulsion-induction, ¼- to 5-hp. motors; squirrel-cage, 60-cycle, two- and three-phase, ¼- to 20-hp. motors; 110- or 220-volt, ¼- to 5-hp., d. c. motors; split-phase, 60-cycle motors of ⅛, ⅙ and ¼ hp. All but the split-phase motors are heavy-duty motors and are provided with either ball or bronze sleeve bearings.

Sundh Electric Company, Inc., 5 Avenue C, Newark, N. J.—Bulletin 18 entitled, "Sundh Electric Control for Fire Pumps," describes the manual, automatic and combined types of control. This booklet also gives the regulations of the National Board of Fire Underwriters and the amendments adopted by the National Fire Protection Association.

Gisholt Machine Company, Madison, Wis.—Bulletin DCT-5 describes the Gisholt direct-current transformer for securing direct current of low voltage from commercial lighting circuits, for operating bells, buzzers, annunciator and call systems, time stamps and clocks, elevator, sprinkler, fire alarm and other signal systems, or in other applications where low voltage, direct current is necessary.

McCord Radiator and Manufacturing Company, Lubricating Division, Detroit, Mich.—A 24-page booklet entitled "The Economy of Better Lubrication" gives the nine outstanding economies claimed to result from the use of McCord forced feed lubricators and illustrates a number of the applications recommended.

The Master Builders Company, Cleveland, Ohio—A 16-page booklet describes "Colormix," which is a concrete hardener, waterproofer and dustproofer in permanent colors and is used in many places where a colored floor or wall is preferred over the natural finish. In addition to a number of applications in various colors, specifications for its use are included.